DOCUMENT RESUME

ED 048 231 SP 007 157

AUTHOR Keeler, Douglas; And Others
TITLE Science; Elementary Pilot Project.
INSTITUTION Farmington Public Schools, Conn.
PUB DATE [68]
NOTE 161p.; A Noah Wallace Income Fund Project

EDRS PRICE EDRS Price MF-$0.65 HC-$6.58
DESCRIPTORS *Curriculum Guides, *Elementary Grades, *Elementary School Science, *Science Curriculum

ABSTRACT

GRADES OR AGES: Elementary grades. SUBJECT MATTER: Science. ORGANIZATION AND PHYSICAL APPEARANCE: The first half of the guide is divided into seven phases which appear to be consecutive. Commercially published units listed in these phases are then described briefly in a list which occupies the second half of the guide. The guide is xeroxed and spiral-bound with a paper cover. OBJECTIVES AND ACTIVITIES: Concepts to be learned and specific behavioral objectives are listed at the beginning of each phase. These are followed by a list of suggested units. A very brief description of the activity is included in the unit description listed in the second half of the guide. INSTRUCTIONAL MATERIALS: All units in the second half are commercially published. A separate list gives names and addresses of publishers. In addition, several appendixes list field trip possibilities, publishers of elementary science materials, film distributors, and equipment and supply distributors. STUDENT ASSESSMENT: A sample "Science Progress Form" for reporting student progress is included in the guide. (RT)

ED0 48231

SCIENCE

ELEMENTARY PILOT PROJECT

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

A Noah Wallace Income Fund Project

Farmington Public Schools Farmington, Connecticut

SP007157

FARMINGTON TOWN BOARD OF EDUCATION

Mr. John Caruso
Mr. Salvatore J. Iritano
Mr. William A. LaPointe
Mr. Paul W. Menzel, Chairman
Rev. Wm. A. McConnell

Mrs. Marguerite Westerberg, Secretary
Mrs. Lillian H. Sheehan
Mrs. Ann H. C. Smith
Mr. William N. Wixon

NOAH WALLACE INCOME FUND ADVISORY COMMITTEE

Mr. James Bishop
Mrs. Arthur Deming
Mr. Francis Hatch
Mr. Salvatore Iritano

Mr. Alfred Mikitas
Mrs. R. Graeme Smith
Mr. Adrian Wadsworth
Mrs. Ralph V. Westerberg

Mrs. Norman C. White

ADMINISTRATION, FARMINGTON PUBLIC SCHOOLS

Superintendent

Mr. John P. McDonough

Assistant Superintendent

Dr. William H. Streich

Coordinator of Instruction

Dr. Joan D. Kerelejza

Business Administrator

Mr. Andrew Lesiak

Principals

Mr. George T. Bennett
Mr. Richard T. Manion
Mr. John McManama

Mrs. Helen McMullen
Mr. Eugene J. Voll
Mr. A. Rodger Wutzl

SCIENCE CURRICULUM STUDY COMMITTEE

1967-1968

Elementary

Mr. Peter Baccaro
Miss Hilda Berube
Mr. Lawrence DeSalvatore
Mrs. Dorothy Dunne

Mrs. Gertrude Gadd
Mr. Douglas Keeler
Mrs. Marion Markovich
Mr. Leo Neckermann

Liaison with Elementary Committee

Mr. C. Leslie Farnum

Mr. John Podolak

WRITING COMMITTEE

Elementary

Mr. Douglas Keeler

Mrs. Donna Gorman
Mrs. Marion Markovich

Mrs. Judith Thompson
Mrs. Marguerite Yung

The committees wish to thank Dr. Joan D. Kerelejza, Coordinator of Instruction, for her guidance in this project. Thanks also are extended to the Noah Wallace Fund Income Advisory Committee for making this curriculum study possible.

TABLE OF CONTENTS

		Page
Foreword		i
Introduction		iv
Programs Funded by National Science Foundation		vi
Phase D		1
Phase I	Physical Science	3
	Life Science	5
	Earth Science	7
S	Physical Science	9
	Life Science	11
	Earth Science	13
C	Physical Science	15
	Life Science	21
	Earth Science	27
O	Physical Science	33
	Life Science	39
	Earth Science	43
V	Physical Science	47
	Life Science	57
	Earth Science	67
E	Physical Science	73
	Life Science	81
	Earth Science	91
AAAS	A Process Approach	97
ESSP	Astronomy	98
ESS	Attribute Games	99
ESS	The Balance Book	100
ESS	Balloons	100
ESS	Batteries and Bulbs	101
ESS	Bones	102
ESS	Brine Shrimp	102
ESS	Budding Twigs	103
ESS	Butterflies	103
ESS	Cardboard Carpentry	104
ESS	Changes	104
ESS	Colored Solutions	104
ESS	Crayfish	105
ESS	Curious Gerbils	105
ESS	Dipping Birds	105
ESS	Drops, Streams, and Containers	106

TABLE OF CONTENTS (continued)

		Page
ESS	Eggs and Tadpoles	106
ESS	Euglena	107
ESS	Gases and Airs	107
ESS	Geo Blocks	108
ESS	Growing Seeds	108
ESS	Heating and Cooling	109
ESS	Kitchen Physics	109
ESS	Lights and Shadows	110
ESS	Mapping	110
ESS	Mealworms	110
ESS	Microgardening	111
ESS	Mirror Cards	111
ESS	Mobiles	112
ESS	Mosquitoes	112
ESS	Musical Instrument Recipe Book	112
ESS	Mystery Powders	113
ESS	Optics	113
ESS	Outdoor Mapping	113
ESS	Pattern Blocks	114
ESS	Peas and Particles	114
ESS	Pendulums	115
ESS	Pond Water	115
ESS	Rocks and Charts	116
ESS	Sand	116
ESS	Sink or Float	116
ESS	Small Things	117
ESS	Snowflakes	117
ESS	Solids and Solutions	118
ESS	Spinning Tables	118
ESS	Tangrams	119
ESS	Where Is the Moon?	120
ESS	Whistles and Strings	120
MINNEMAST	Curves and Shapes	121
MINNEMAST	Describing and Classifying	121
MINNEMAST	Describing Locations	121
MINNEMAST	Exploring Symmetrical Patterns	122
MINNEMAST	Introducing Measurement	122
MINNEMAST	Introducing Symmetry	122
MINNEMAST	Investigating Systems	122

TABLE OF CONTENTS (continued)

Page
MINNEMAST Living Things in Field and Classroom 123
MINNEMAST Measuring With Reference Units 123
MINNEMAST Observing Properties 123
MINNEMAST Using Our Senses 123
MINNEMAST Watching and Wondering 124
SCIS Interaction 125
SCIS Life Cycles 126
SCIS Material Objects 127
SCIS Organisms 128
SCIS Phases of Matter 129
SCIS Populations 130
SCIS Position and Motion 131
SCIS Relativity 131
SCIS Systems and Subsystems 132
Children's Museum 133
Farmington-Green Plants-Elementary Science 133
Science Research Associates 133
Talcott Mountain Science Center 134
Resources and Field Trip Possibilities 135
Science Progress Form 136
Appendix - Publishers 137
Film and Filmstrip Distributors 144
Equipment and Supply Distributors 146
ESS Films and Film Loops 148

FOREWORD

Today's science program is a far cry from what typified science study as recently as ten years ago. The former emphasis upon mastery of factual information, upon reading a single text, and upon teacher demonstrations watched by the entire class has been superseded by a dynamic, resourceful investigation of natural phenomena. Today's elementary and secondary student within the classroom is an active seeker of the truth in just as legitimate a manner as is the scientist within his laboratory.

Active student involvement in the study of science characterizes the program developed for the Farmington Schools. At all levels, students are taught by a "discovery," laboratory-centered approach in which they probe, measure, dissect, calibrate, record, evaluate, and predict in order to gain an understanding of the ways in which a scientist interprets the world and a familiarity with the processes which he employs. Each child for himself discovers anew the wonder of man's attempt to master the unknown.

Another fundamental emphasis in the Farmington program is on helping students acquire the thinking patterns essential to scientific investigation. The "scientific method" is seen as a constellation of methods involving many sub-sets of related skills which students must master to gather and interpret scientific data with understanding. Basic skills or processes particularly appropriate to the discipline of science were identified in this summer's study, and learning situations for children were developed.

A third basis for the elementary and the secondary programs is the development of certain key scientific concepts, beginning with the child's immediate physical environment and extending to sophisticated ideas of relativity. Burgeoning factual information in the discipline has forced the establishment of a criterion for competence other than the mastery of a relatively small body of essential content. When one is faced with the prospect that the amount of scientific factual knowledge will double every seven years, no particular content remains sacrosanct. The Farmington program stresses basic scientific concepts and suggests many specific contents that best seem to develop these concepts. Making an informed professional choice from among a variety of contents became the task of the curriculum study committee. It was a matter of selecting the content most appropriate for teaching the basic concepts.

Finally, just as there is no inviolate content that all children must master, so is there no single type of instructional material that can benefit every child. The teacher must have available many types of instructional tools and devices - not a single text but many texts; not one microscope, but many microscopes.

At both the elementary and the secondary levels, the pilot programs in science developed for trial during this coming school year reflect provision for active student participation within the classroom or the laboratory, emphasize a teacher-guided discovery approach to learning, stress student acquisition of basic thinking processes in the discipline of science, identify basic concepts that can be taught with a variety of contents, and require the availability of many types of instructional materials.

ELEMENTARY PROGRAM

The writing committee first identified basic processes essential to the discipline of science and the fundamental concepts about science which would help children understand the world about them. These concepts would serve as building blocks for advanced science study in the secondary schools. The committee felt that content should be selected from the child's immediate environment and experience.

This year, science teachers in the elementary school will have available the plant study units developed last summer for the primary and intermediate levels and a new organization for the science program reflected in the guide. So much excellent new science material is now available commercially that the writing committee felt it advisable to organize this material around the framework of a total elementary science program. As a result, commercial materials have been carefully reviewed and chosen to fill slots in the general program. In this way, the committee will be able to determine the suitability of these materials as recommended and will also be able to locate areas for which we will need to prepare our own units. As far as possible, basic concepts are emphasized and objectives are stated in terms of what students should be able to accomplish. As much flexibility as possible has been encouraged. Learning activities are open ended so that teachers can modify or supplement as needed. The use of many resource materials is anticipated; no basic materials are used. Teachers should feel free to capitalize on the interest and curiosity of a particular group of children. Hopefully, suggestions in the guide will serve only as a basic core from which the teacher works.

SECONDARY PROGRAM

The secondary program was considered as one in which students gradually refine fundamental scientific processes and concepts begun in the elementary program as content becomes more specialized. The ultimate goal is to develop a non-graded program which will enable students to make meaningful contact with the ideas of science as these are taught through laboratory experiences. With a laboratory-centered program, all students should see science as a discipline of process and inquiry rather than as a body of facts that must be learned.

In the transition years of the junior high school, the concepts and assumptions acquired through laboratory experiences should reveal nature to be dynamic and varied. The junior high school student should think of the world and the phenomena in it as consisting of sets of relationships rather than of absolutes. The program should continue to give students experiences with many areas of science. As a result, the curriculum study committee recommended that additional biological studies be included in the junior high school program to counterbalance the heavy emphasis on the physical sciences. The writing committee prepared two biological units for the first-year program. It also suggested that modification of the existing physical science sections be made by introducing parts of the Introduction to Advanced Science and of the Introduction to Physical Science courses. The portions of the new program prepared this summer will be used with pilot classes this school year.

The senior high writing committee completely revamped the existing Introduction to Advanced Science course. Revisions were made on the basis of four years of classroom experience. This group is anticipating the preparation of a truly non-graded science program for the high school level over the next two years and looks upon this curriculum as a transitional one.

As groups of teachers and administrators earnestly struggle with philosophical and practical considerations in the preparation of any new curriculum, the tendency to become entrapped in immediate concerns is always a danger. If the Farmington science curriculum is to be outstanding, teachers must not lose sight of its ultimate aim - the sustaining of the feeling of wonder as students probe into the unknown. We can all profit from the lesson taught by Whitman's learned astronomer:

> When I heard the learn'd astronomer,
> When the proofs, the figures, were ranged in columns before me,
> When I was shown the charts and diagrams, to add, divide, and
>   measure them,
> When I sitting heard the astronomer where he lectured with much
>   applause in the lecture room,
> How soon unaccountable I became tired and sick,
> Till rising and gliding out I wander'd off by myself,
> In the mystical moist night air, and from time to time,
> Look'd up in perfect silence at the stars.

For the Committee,
Joan D. Kerelejza

INTRODUCTION

Children today live in a new world of science, and it seems to be getting "newer" every day. There are new discoveries, new medicines, new ways of doing things, new kinds of jobs. We are living in a very dynamic and exciting time of history. A science curriculum must keep pace with the world of its children. Therefore, new goals and new instructional materials based upon the needs of a changing society, strongly influenced by science, characterize today's elementary-school science programs. The conceptual curricular materials suggested in this guide differ from conventional science programs in rationale, implementation in the classroom, and content. They are based on new ideas of how children learn and thus require changes in the way science is taught.

Learning is exciting. It moves, it breathes, and it becomes larger under a microscope. In order to enhance this new world of science, children should be allowed the freedom to create, to become actively involved in their own learning, and to become responsible for their learning endeavor. The classroom will become a laboratory where each child assumes the role of a creator, a discoverer, an operator -- and not simply a passive listener. The classroom will be noisier, messier, and more stimulating for both child and teacher. To teach this new approach to science, a teacher need not have a strong background in science. The teacher need only be aware of individual differences and be totally sensitive to the process of education. He will become adept as he talks with fellow teachers, as he observes his children's total involvement, and as he begins to find in the new world of science a fascinating and illuminating biography of life.

This curriculum is based on the integration of life science, earth science, and the physical sciences. Its basis lies in its construction, a construction that places complex experiences, broader treatment, and greater depth in higher levels but intrinsically depends on lower levels for a solid base. It is difficult for children to understand the knowledge of science without an awareness of how that knowledge was formed. The processes of science developed in this curriculum provide young people with thinking tools applicable not only to science but to life in general. These processes include:

1. Observation
2. Classification
3. Measurement
4. Communication
5. Interpretation of data
6. Drawing inferences
7. Setting up experiments
8. Making predictions
9. Application of processes to unfamiliar situations.

The units in this curriculum have been trial tested, have the support of the National Science Foundation, and are consistent with present-day learning theory. It is the hope of this committee that science is not taught in isolation from the total curriculum. Many of the suggested units can be correlated with language arts, math, social studies, physical education, music, and art. Supplemental units, such as Tangrams, Geo Blocks, and Attribute Games, can be used at every level and should remain in the classroom for a child with free time.

The guide contains a list of resources which is not complete. A teacher may add his own, or if he is developing his own materials, he should list them so that future revisions can make the list more complete. It is hoped that teacher-devised units may find their way to this committee.

Science Curriculum Improvement Study (SCIS) units explore many areas of science, based on both a development of skills and concepts. SCIS maintains active student participation. The vocabulary in these units is more scientific than in many of the other units recommended. SCIS maintains, too, outstanding background information for the teacher. Elementary Science Study (ESS), on the other hand, leaves the teacher to his creative instincts. It is hoped that by contrasting the two types of units, teachers will have an interesting and lively framework for class activities. Some of the units suggested are still in preparation, but are scheduled for commercial publication during the school year 1968-69.

In closing, this committee suggests that manuals and materials be kept in a central location in the school when not actively in use in the classroom.

"I hear and I forget
I see and I remember
I do and I understand."

Education Development Center

Programs Funded by National Science Foundation

American Association for the Advancement of Science (AAAS)
Xerox Corporation
600 Madison Avenue, New York, New York 10022

Elementary-School Science Project (ESSP)
University of Illinois
Urbana, Illinois

Elementary Science Study (ESS)
Educational Development Center, Inc.
55 Chapel Street, Newton, Massachusetts 02160

Minnesota Mathematics and Science Teaching Project (MINNEMAST)
720 Washington Avenue S.E., Minneapolis, Minnesota 55414

Science Curriculum Improvement Study (SCIS)
University of California
Berkeley, California 94720

Concepts When energy and matter change from one form to another, the total amount of energy and matter remains unchanged.

A living thing is the product of its heredity and environment.

The universe is in constant change.

Subconcepts

Matter is characterized by certain properties by which it can be described and classified.

Living things may differ in structure, but they have common needs and similar life activities.

There are daily changes on earth.

Suggested Units

MINNEMAST
    Watching and Wondering
    Curves and Shapes

MINNEMAST
    Describing and Classifying
    Using Our Senses

MINNEMAST
    Introducing Measurement
    Introducing Symmetry
    Observing Properties

Teacher-Devised Units

Supplementary Units: Phase D

Supplemental units which meet behavioral objectives of this phase. These units may be used separately or in conjunction with other units.

Elementary Science Study
    Mirror Cards
    Attribute Games
    Pattern Blocks
    Tangrams
    Geo Blocks
    Lights and Shadows
    Curious Gerbils
    Growing Seeds

American Association for the Advancement of Science Part A

Teacher-Devised Units

Phase D

Behavioral Objectives

The child should demonstrate the ability to:

identify a number of objects.

name similarities and differences based on such characteristics as color, size, shape, weight, smell, texture, taste, temperature, and sound.

classify objects on the basis of what they do and how they react.

measure by comparison.

recognize simple geometric shapes and curves.

classify spacial relationships in terms of direction: up, down, near, far, right, left.

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase I PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.
B - When matter changes from one form to another, the total amount of matter remains unchanged.

ubconcepts

- 1 A net force is needed to start, stop, or change the direction of motion.

- 2 Energy must be used to set an object in motion.

- 1 Matter is characterized by certain properties by which it can be identified and classified.

- 2 Matter commonly exists as solids, liquids, and gases.

Suggested Units

Science Curriculum Improvement Study
    Material Objects

MINNEMAST
    Observing Properties

Teacher-Devised Units

Supplementary Units:
Supplemental units which meet behavioral objectives of this phase. These units may be used separately or in conjunction with other units.

MINNEMAST
    Introducing Symmetry
    Describing Locations
    Measurement with Reference Units
    Using Our Senses

Elementary Science Study
    Attribute Games
    Geo Blocks
    Creature Cards
    Tangrams
    Cardboard Carpentry
    Mirror Cards
    Musical Instrument Recipe Book

American Association for the Advancement of Science Part

Teacher-Devised Units

hase I PHYSICAL SCIENCE

ehavioral Objectives

he child should demonstrate the ability to:

observe and record changes in matter; i.e., metals, gases, woods.

act upon and experiment with objects in the solid, liquid, and gaseous states.

describe the relationship between changes in observed properties and a time sequence; i.e., the changing of a solid to a liquid.

recognize and describe an event or a series of events in terms of their occurrence in time.

communicate observations by way of charts, graphs, and worksheets, as well as make precise verbal descriptions.

verify observations by repeating the activity.

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

*These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase I LIFE SCIENCE

Concept C - Living things are interdependent with one another and their environment.

D - A living thing is the product of its heredity and environment.

E - Living things are in constant change.

Subconcepts

C - 1 Living things are affected by their environment.

C - 2 Living things depend on their environment for the conditions of life.

C - 3 There are characteristic environments, each with its characteristic life. (habitat)

C - 4 Living things capture matter from the environment and return it to the environment.

D - 1 Living things may differ in structure but have common needs and similar life activities.

D - 2 Living things reproduce.

D - 3 Related living things reproduce in similar ways.

E - 1 There are different forms of living things.

E - 2 Forms of living things have become extinct.

E - 3 Living things grow and develop in different environments.

E - 4 The environment is in constant change.

Suggested Units

Science Curriculum Improvement Study
- Organisms

Elementary Science Study
- Brine Shrimp
- Butterflies
- Budding Twigs
- Growing Seeds
- Curious Gerbils
- Eggs and Tadpoles

MINNEMAST
- Living Things in Field and Classroom (Teacher's Handbook)

Teacher-Devised Units

Phase I LIFE SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

observe changes in living things such as guppies and plants, and describe their properties.

observe and distinguish between various phases of change; i.e., egg to adult, seed to mature adult.

recognize that animals have certain characteristics in common: they can move from place to place; they breathe and eat food; they grow and reproduce their own kind.

recognize interdependency between animals and their environments.

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase I EARTH SCIENCE

Concept F - The universe is in constant change.

Subconcepts

F - 1 Things change.

F - 2 There are daily changes on earth.

Suggested Units

Elementary Science Study
- Sand
- Spinning Tables
- Rocks and Charts
- Lights and Shadows
- Snowflakes

Talcott Mountain Science Center
- Rocks
- Volcanoes

Children's Museum Planetarium

Teacher-Devised Units

Behavioral Objectives

The child should demonstrate the ability to:

manipulate and classify different kinds of objects; i.e., metals, gases, woods, liquids, rocks.

recognize and describe material objects in his own environment.

describe the properties of observed objects in terms of shape, color, texture, density, and hardness.

apply the concept of material to the task of sorting a collection of objects; i.e., rocks, metals.

communicate observations by way of charts, graphs, and worksheets, as well as make precise verbal descriptions.

verify observations by repeating the activity.

recognize and describe an event or a series of events in terms of their occurrence in time.

arrange similar objects in serial order according to some property; i.e., length, texture, size.

distinguish between changes of day and night, weather and seasons.

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase S - PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.
B - When matter changes from one form to another, the total amount of matter remains unchanged.

Subconcepts

A - 1 A net force is needed to start, stop, or change the direction of motion.

A - 2 Energy must be used to set an object in motion. There are many forms of motion.

A - 3 Energy can change from one form to another.

A - 4 Objects interact and show evidence of their interaction.

A - 5 Subsystems store energy and transfer it as changes occur within a system.

A - 6 A whole, its parts, and their interrelationships make up a system.

B - 1 Matter (an object or a thing) is characterized by certain properties by which it can be identified and classified.

B - 2 Matter commonly exists as solids, liquids, and gases.

B - 3 A change in the state of matter is determined by molecular motion.

B - 4 In chemical or physical changes, the total amount of matter remains unchanged.

B - 5 Matter in a system may be mentally or physically subdivided, rearranged, or changed in appearance without destroying the identity of the system so long as no matter is added or omitted.

Suggested Units

Science Curriculum Improvement Study
- Interaction

Elementary Science Study
- Sink or Float
- Drops, Streams, and Containers
- Spinning Tables
- Changes

MINNEMAST
- Investigating Systems

Teacher-Devised Units

Supplementary Units: Phase S

Supplemental units which meet behavioral objectives for this phase. These units may be used separately or in conjunction with other units.

MINNEMAST
- Introducing Measurement
- Introducing Symmetry
- Describing Locations
- Measurement with Reference Units

Elementary Science Study
- Mirror Cards
- Attribute Games
- Tangrams
- Primary Balancing
- Cardboard Carpentry
- Structures
- Creature Cards
- Geo Blocks
- Musical Instrument Recipe Book

American Association for Advancement of Science Part C

Teacher-Devised Units

Behavioral Objectives

The child should demonstrate the ability to:

observe and identify changes in matter as a result of interaction of objects such as battery and bulb, bromothynol blue and vinegar, roller skate and magnet.

identify solids, liquids, and gases as in a pencil, water, and air.

use common measurement instruments to compare areas and volumes, scales and units of measurement, relationship of points, lines and angles.

make two-dimensional drawings of three-dimensional objects.

recognize and record changes that occur during an experiment such as the interaction of copper chloride and water.

recognize that the matter in a system is conserved even though the objects change in arrangement or appearance; e.g., the dissolving of a candy sphere in water or the interaction of copper chloride solution and aluminum.

construct and operate a system; i.e., pulley, electric circuit.

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase S LIFE SCIENCE

Concept C - Living things are interdependent with one another and with their environment.

D - A living thing is the product of its heredity and its environment.

E - Living things are in constant change.

Subconcepts

C - 1 Living things depend on their environment for the conditions of life.

C - 2 There are characteristic environments, each with its characteristic life.

C - 3 Living things capture matter from the environment and return it to the environment.

D - 1 Related living things reproduce in similar ways.

D - 2 Living things are related through possession of common structures.

D - 3 A living thing reproduces itself and develops in a given environment.

D - 4 Living things have the capacity to produce an enormous number of offspring.

E - 1 There are different forms of living things.

E - 2 Forms of living things have become extinct.

E - 3 Living things grow and develop in different environments.

Suggested Units

Science Curriculum Improvement Study
    Life Cycles

Elementary Science Study
    Eggs and Tadpoles
    Budding Twigs
    Butterflies
    Mealworms
    Brine Shrimp
    Curious Gerbils
    Growing Seeds
    Mosquitoes
Farmington Unit on Plants

MINNEMAST

    Living Things in Field and Classroom
        (Teacher's Handbook)

Teacher-Devised Units

Phase S LIFE SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

observe and distinguish characteristic changes in the life cycle of living things such as frogs, budding twigs, butterflies, mealworms, plants, and crickets.

observe and classify living and non-living objects.

identify environments that are necessary for the growth and development of living things.

* exercise intuitive thinking as a result of his experience with individualized material.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase S EARTH SCIENCE

Concept F - The universe is in constant change.

Subconcepts	Suggested Units
F - 1 There are daily changes on earth.	Elementary Science Study Where Is the Moon? Mobiles Rocks and Charts Lights and Shadows Sand
F - 2 There are regular movements of the earth and the moon.	Talcott Mountain Science Center Rocks Volcanoes
	Children's Museum Planetarium
	Teacher-Devised Units

Behavioral Objectives

The child should demonstrate the ability to:

observe and record changes in spacial relationships of light and shadows; moon, planets, sun, and earth.

observe and classify rocks.

identify a number of time intervals such as minutes, hours, days, weeks, months, seasons, and years.

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase C PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.
B - When matter changes from one form to another, the total amount of matter remains unchanged.

Subconcepts

A - 1 Energy can change from one form to another.

A - 2 A loss or gain of energy affects molecular motion.

A - 3 Systems contain subsystems, or systems contained within another system.

A - 4 Objects interact and show evidence of their interaction.

A - 5 Subsystems store energy and transfer it as changes occur within a system.

B - 1 Matter is characterized by certain properties by which it can be identified and classified.

B - 2 Matter commonly exists as solids, liquids, and gases.

B - 3 A change in the state of matter is determined by molecular motion.

B - 4 In chemical change, atoms react to produce change in molecules.

B - 5 In chemical and physical changes, the total amount of matter remains unchanged.

B - 6 Matter in a system or subsystem may be mentally or physically subdivided, rearranged, or changed in appearance without destroying the identity of the system or subsystem so long as no matter is added or omitted.

Suggested Units

Science Curriculum Improvement Study
  Systems and Subsystems

MINNEMAST
  Investigating Systems
  Exploring Symmetrical Patterns

Elementary Science Study
  Mystery Powders
  Changes
  Drops, Streams, and Containers

Behavioral Objectives

The child should demonstrate the ability to:

measure by using common units of measure such as inches, centimeters, quarts, or records.

measure values and record length, area, volume, time duration, and time order.

use symbols for comparisons and apparent equalities.

make distinctions among perimeters, areas, and volumes.

use centimeter and inch grid sheets.

recognize variables; identify their effects, such as temperature, time intervals, nature and number of objects in a system, distance and time; and control these variables.

record data by use of histograms.

recognize observable changes within a system as evidence of interaction.

manipulate a number of materials: magnets, syringes, vials, and electric circuits.

recognize that systems of another system make up subsystems.
identify connected subsystems in a system of electric circuits.
distinguish a solution from other mixtures.

separate undissolved solid substances from a liquid by a filtering process.

predict that dissolved solid materials can be recovered from a solution by evaporation.

obtain crystals from a solution by evaporation.

identify the residue of solutions after evaporation.

construct different systems and subsystems.

recognize different sources of energy.

describe melting of solids, boiling and evaporation of liquids, and liquefying of gases.

Subconcepts

Suggested Units

Sand

Sink or Float

Teacher-Devised Units

Supplementary Units: Phase C

Supplementary units which meet behavioral objectives for this phase. These units may be used separately or in conjunction with other units.

Elementary Science Study
- Tangrams
- Creature Cards
- Attribute Games
- Structures

Phase C PHYSICAL SCIENCE

Behavioral Objectives

associate a certain fixed temperature with melting.

distinguish between samples of liquid Freon and water.

plan and conduct experiments where one variable is changed.

---

compare properties of sand to those of other substances.

use sand to time, count, measure, and weigh.

explore color and texture in making of pictures, sculpture, and jewelry.

---

observe that the balance act is dependent on the properties of the objects which are being weighed.

order objects in his environment according to their weight.
sort objects which float and sink by changing a variable.
devise ways to make objects that float, sink and those that sink, float.

---

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Subconcepts

Suggested Units

Mirror Cards
Cardboard Carpentry

The Chemistry of a Lemon
The Chemistry of Soap
Plants Are Like That
Puttering with Paper
Rocks and Rills
Take a Balloon

American Association for Advancement of Science Part

Phase C PHYSICAL SCIENCE

Behavioral Objectives

Concept C - Living things are interdependent with one another and with their environment.
D - A living thing is the product of its heredity and its environment.
E - Living things are in constant change.

Subconcepts

C - 1 Living things depend on their environment for the conditions of life.

C - 2 There are characteristic environments, each with its characteristic life.

C - 3 Living things capture matter from the environment and return it to the environment.

C - 4 Living things are dependent on a particular environment.

C - 5 The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.

C - 6 A number of similar organisms living and reproducing in a given area make up a population.

C - 7 The relationship of different populations living in the same area makes up a community.

D - 1 Related living things reproduce in similar ways.

D - 2 Living things are related through possession of common structure.

D - 3 A living thing reproduces itself and develops in a given environment.

D - 4 Living things have the capacity to produce an enormous number of offspring.

D - 5 Living things tend to overpopulate.

Suggested Units

Science Curriculum Improvement Study
  Populations

Elementary Science Study
  Pond Water
  Euglena
  Peas and Particles
  Eggs and Tadpoles

Farmington Unit on Plants

MINNEMAST
  Living Things in Field and Classroom

Teacher-Devised Units

Behavioral Objectives

The child should demonstrate the ability to:

identify various populations of living things and explain how and why they comprise a community.

recognize that different populations of plants and animals live together in the same area.

recognize that numbers of organisms in any one population can increase or decrease and that the change in numbers is dependent on two factors: (1) reproduction within each population; (2) food relations among different populations.

state and demonstrate the difference between predator (hydra) and prey (Daphnia).

recognize that populations of living things (dragonfly nymphs) compete for food.

recognize that duckweed plants grow from an older larger duckweed plant in a type of budding.

make conclusions as a result of evidence obtained by his experiments.

construct a complex terrarium.

recognize that the source of all human food is either plant or animal.

identify and classify organisms under the categories "plant-eater" and "animal-eater."

identify parts of a plant.

record observations of living things by drawing pictures.

recognize some ways in which predators catch their prey (keen eyesight and swift, decisive movement) and some ways in which prey escape being eaten (hiding, flying away, freezing).

recognize that some animals are both predator and prey.

illustrate predator-prey relationships by a drawing.

identify the linear food relationship among animal-eaters, plant-eaters, and plants as a food chain.

Phase C LIFE SCIENCE

Subconcepts

E - 1 There are different forms of living things.

E - 2 Forms of living things have become extinct.

E - 3 Living things grow and develop in different environments.

E - 4 The environment is in constant change.

E - 5 Living things living in an environment compete for food.

Suggested Units

MINNEMAST
Exploring Symmetrical Patterns

Behavioral Objectives

recognize that green plants are the origin of all food chains.

recognize that a population would increase rapidly if reproduction continued normally without any deaths.

recognize that food chains interconnect to form a food web.

construct a complex aquarium.

count organisms in a population.

record on charts numbers of organisms in a given population.

prepare hypothesis about causes for the disappearance or growth of living things in a population and community.

design experiments to test hypothesis about causes for the disappearance or growth of living things in a population or community.

discuss and describe his observations of life in aquaria and terraria.

present and discuss findings as a result of his experimenting.

observe feeding behavior of aquaria and terraria animals.

use various instruments to assist in observation, including microscopes, hand lenses, medicine droppers, etc.

infer that mother plants are offspring from larger parent plants of the same species.

---

recognize symmetry in nature, music, poetry, and art.

recognize turning symmetry (rotational symmetry), repeating patterns (translational symmetry), and symmetry about a line (bilateral symmetry).

Subconcepts

Suggested Units

MINNEMAST
    Exploring Symmetrical Patterns

ehavioral Objectives

make the necessary tests and comparisons for the three types of symmetry studied.

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase C EARTH SCIENCE

Concept F - The universe is in constant change.

Subconcepts

F - 1 There are daily changes on earth.

F - 2 There are regular movements of the earth and the moon.

F - 3 The motion and path of celestial bodies are predictable.

F - 4 Position and motion of an object can be perceived, described, and recognized only with reference to other nearby objects.

F - 5 Position and motion are relative to reference points.

Suggested Units

Science Curriculum Improvement Study
    Relativity

MINNEMAST
    Describing Locations
    Measurement with Reference Units

Elementary Science Study
    Spinning Tables

Teacher-Devised Units

Behavioral Objectives

The child should demonstrate the ability to:

discriminate small differences in relative position, distance, direction, and arrangement of objects.

be independent in organizing a problem.

describe the position of objects or systems in the classroom.

state and demonstrate that objects used to help describe other objects are called "reference objects."

describe position relative to himself.

describe position relative to other objects.

describe position of objects or systems relative to another system.

use composite terms for describing directions.

construct reference frames from paper.

measure distances by use of paces.

identify the direction from which the picture of a system was taken.

identify relative position of objects from a photograph.

use a specified reference frame for describing relative position.

describe position by use of landmarks.

recognize and describe changes of relative position.

interpret changes of relative position as relative motion.

choose reference frames for the description of relative motion.

Subconcepts	Suggested Units
	Elementary Science Study Mobiles
	Optics
	Rocks and Charts
	Where Is the Moon?
	Sand

Behavioral Objectives

recognize and describe relative motion qualitatively.

choose reference frames for describing relative motion.

make pictorial representations of relative motion.

measure by using reference standards such as clips, corks, and pendulums.

---

experiment with balance by making constructions that are pleasing to the eye.

---

recognize and analyse properties of light by direct experiments.

recognize the interaction of light with transparent objects and objects that act as mirrors.

---

observe and classify rocks.

communicate observations by way of charts, graphs, and worksheets, as well as make precise verbal descriptions.

---

observe and record changes in spacial relationships of light and dark; moon, planets, sun, and earth.

---

compare properties of sand to those of other substances.

use sand to time, count, measure, and weigh.

explore color and texture in making of pictures, sculpture, and jewelry.

Phase C EARTH SCIENCE

Subconcepts

Suggested Units

Talcott Mountain Science Center
    Rocks
    Volcanoes

Children's Museum Planetarium

Behavioral Objectives

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase O

PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.

B - When matter changes from one form to another, the total amount of matter remains unchanged.

Subconcepts	Suggested Units
A - 1 Energy must be used to set an object in motion. A - 2 Energy can change from one form to another. A - 3 A loss or gain of energy affects molecular motion. A - 4 Energy must be applied to produce an unbalanced force, resulting in motion or change of motion.	Science Curriculum Improvement Study Position and Motion Approaches to Equilibrium (In preparation) Elementary Science Study Pendulums Spinning Tables Optics
B - 1 A change in the state of matter is determined by molecular motion. B - 2 Matter consists of atoms and molecules. B - 3 In chemical or physical changes, the total amount of matter remains unchanged.	Elementary Science Study Gases and Airs Elementary Science Study Whistles and Strings Elementary Science Study Balancing

Behavioral Objectives

The child should demonstrate the ability to:

use rectangular coordinates to describe position.

infer properties of motion from tracks left by moving objects.

analyze and describe tracks made by spheres colliding with each other and with fixed objects.

---

devise simple experiments which indicate the presence of air.

collect evidence of the interaction of objects with air.

conduct experiments involving the use of controls, such as experiments with steel wool and "candle air" compared with "room air," and identify variables which are manipulated and those which are constant.

---

construct a simple stringed instrument and play a simple tune, using the instrument.

investigate tubes that make sounds when blown into and experiment with these materials to make different sounds.

---

identify problems involving balance and make use of various strategies to solve the problems.

understand intuitively moments of force and center of mass.

predict outcomes in terms of asymmetric balance and counterbalance.

Subconcepts

Suggested Units

Elementary Science Study
Sink or Float

Elementary Science Study
Mystery Powders

Elementary Science Study
Solids and Solutions

Talcott Mountain Science Center
Light Spectra

Teacher-Devised Units

Supplementary Units: Phase 0

Supplementary units which meet behavioral objectives for this phase. These units may be used separately or in conjunction with other units.

Phase O   PHYSICAL SCIENCE

Behavioral Objectives

observe that the balance act is dependent on the properties of the objects which are being weighed.

order objects in his environment according to their weight.

sort objects which float and sink by changing a variable.

devise ways to make objects that float, sink and those that sink, float.

---

identify properties of various substances by taste, smell, touch, and comparison with known substances.

use indicators to detect the presence of certain substances such as heat, iodine, and vinegar.

record and chart the results of experiments with various substances.

identify the composition of some mixtures by using various indicators.

---

predict and verify through experiment the solids which dissolve in water and those which do not.

determine how much salt will dissolve in a given amount of water.

observe and predict changes of the water level when solids dissolve in water.

---

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Subconcepts

Supplementary Units: Phase 0

MINNEMAST
  Describing Locations
  Measurement with Reference Units

Elementary Science Study
  Attribute Games
  Creature Cards
  Mirror Cards
  Tangrams
  Peas and Particles
  Pattern Blocks
  The Chemistry of a Lemon
  The Chemistry of Soap
  The Last Tree Bird
  Plants Are Like That
  Puttering with Paper
  Rocks and Rills
  Take a Balloon

Phase O PHYSICAL SCIENCE

Behavioral Objectives

Phase 0 LIFE SCIENCE

Concept C - Living things are interdependent with one another and with their environment.
D - A living thing is the product of its heredity and its environment.
E - Living things are in constant change.

Subconcepts

C - 1 Living things depend on their environment for the conditions of life.

C - 2 There are characteristic environments, each with its characteristic life.

C - 3 Living things capture matter from the environment and return it to the environment.

C - 4 The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.

C - 5 Living things are adapted by structure and function to their environment.

C - 6 Green plants get the matter for growth from water, soil, and air.

D - 1 Living things are related through possession of common structure.

D - 2 A living thing reproduces itself and develops in a given environment.

D - 3 An organism needs food for growth.

D - 4 All living things have inborn behavior that adapts them to their environment.

Suggested Units

Science Improvement Curriculum Study
    Environmental Influence

Elementary Science Study
    Brine Shrimp
    Behavior of Mealworms
    Pond Water
    Euglena
    Butterflies
    Mosquitoes
    Eggs and Tadpoles
    Growing Seeds
    Curious Gerbils
    Budding Twigs
    Microgardening
    Crayfish

Farmington Unit on Plants

MINNEMAST
    Living Things in Field and Classroom

Elementary Science Study
    Changes

Behavioral Objectives

The child should demonstrate the ability to:

prepare slides for use under a microscope and use the process of staining.

observe and record the structure, habits, and locomotion of an organism such as a mealworm.

conduct experiments exploring the response of an organism to a certain stimulus.

report the behavior of an organism such as a mealworm to experiments in following an obstacle course.

identify some of the plants and animals found in ponds and observe the interactions of these plants and animals.

---

discuss things that change and make some prediction about what will happen to things that are left alone.

list his predictions of the ways in which things will change if put into containers.

identify types of changes occurring.

Subconcepts	Suggested Units
D - 5 Behavior may be inborn or learned.	
D - 6 A living thing may be adapted to different environments.	
E - 1 Living things develop and grow in different environments.	Teacher-Devised Units
E - 2 The environment is in constant change.	
E - 3 Living things have changed over the ages.	

ehavioral Objectives

understand natural changes with things that change without man's intervention.

understand that growth and decay are part of the same cycle of life.

discuss, record, and classify some changes.

understand that timing is involved in spontaneous changes.

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase 0 EARTH SCIENCE

Concept F - The earth is in constant change.

Subconcepts

F - 1 There are regular movements of the earth and the moon.

F - 2 The motion and path of celestial bodies are predictable.

F - 3 The point or area in space actually occupied by a physical object or into which it is placed is its position.

F - 4 Objects change place or position.

F - 5 Position and motion of an object can be perceived, described, and recognized only with reference to other nearby objects.

F - 6 Position and motion are relative.

Suggested Units

Science Curriculum Improvement Study
Position and Motion

Elementary Science Study
Where Is the Moon?

Mapping

Behavioral Objectives

The child should demonstrate the ability to:

identify and use measurement of distance in miles, centimeters, and millimeters and measurement of direction in terms of degrees.

use rectangular coordinates to describe position.

infer properties of motion from tracks left by moving objects.

describe tracks by using rectangular coordinates.

analyze and describe tracks made by spheres colliding with each other and with fixed objects.

identify and record regular movements of the earth and the moon.

---

observe and record changes in spacial relationships of light and shadows; moon, planets, sun, and earth.

identify a number of time intervals such as minutes, hours, days, weeks, months, seasons, and years.

---

describe his environment through the use of symbols, grids, and landmarks.

map various land features such as hills, streams, and cliffs.

represent three dimensions in two.

show the relative position of objects in space.

estimate shape and size of objects in the environment.

make scale drawings.

Subconcepts

Suggested Units

Optics

Science Research Associates
    Earth's Atmosphere Laboratory
    Weather and Climate Laboratory
    Solar System Laboratory

MINNEMAST

    Describing Locations
    Measurement with Reference Units

Talcott Mountain Science Center

    Stars
    Planets

Children's Museum Planetarium

Teacher-Devised Units

Behavioral Objectives

recognize and analyze properties of light by direct experiments.

recognize the interaction of light with transparent objects and objects that act as mirrors.

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase V PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.

B - When matter changes from one form to another, the total amount of matter remains unchanged.

Subconcepts

A - 1 Energy can change from one form to another.

A - 2 A loss or gain of energy affects molecular motion.

A - 3 Energy must be applied to produce an unbalanced force, resulting in motion or change of motion.

A - 4 The amount of energy gotten out of a machine does not exceed the energy put into it.

A - 5 To move an object, energy must be applied to overcome the pull of gravitation.

A - 6 Every action has an equal and opposite reaction.

B - 1 Matter commonly exists as solids, liquids, and gases.

B - 2 Matter consists of atoms and molecules.

B - 3 A change in the state of matter is determined by molecular motion.

B - 4 In chemical change, atoms react to produce change in the molecules.

B - 5 In chemical or physical changes, the total amount of matter remains unchanged.

B - 6 In nuclear reactions a loss of matter is a gain in energy. The sum of matter and energy remains constant.

B - 7 When any two parts of a system behave differently when treated with the same test substance, they are not the same kind of material, nor are they the same phase.

Suggested Units

Science Curriculum Improvement Study

Phases of Matter

Behavioral Objectives

The child should demonstrate the ability to:

apply the concept phase of matter to materials he judges to be uniform and homogeneous.

apply schlieren tests and drop tests as evidence of uniformity or lack of uniformity in liquids and for the existence of one or more phases.

recognize volume and mass as measures of amount of substance and apply them in making solutions reproducibly.

recognize new phases forming when solutions are mixed.

recognize reproducibility in reactions between solutions.

apply concentration as a measure of relative amounts of the components in a solution.

relate the color of cobalt chloride in water solution both to the concentration and to the total amount of the cobalt chloride in the solution.

compare the weight of some systems before and after reactions producing new phases.

distinguish between the solids and solutions which are electrical conductors and those which are not.

recognize the forming of new phases at electrodes in electrically conducting liquids.

recognize different kinds of gases and identify several kinds by their reactions with test substances.

expect conservation of matter in gas-producing reactions as well as in other reactions.

recognize some gaseous solutions.

Subconcepts	Suggested Units
	Energy (In preparation)
	Elementary Science Study Batteries and Bulbs

Behavioral Objectives

---

use what he has already learned to make predictions.

investigate at his own rate in the direction dictated by the materials and by the limits of his imagination.

make generalizations that come out of his actual experience with the materials. (For example, a coil of wire in a complete electrical circuit acts as a magnet.)

check his experiments, compare, discuss results, and propose explanations.

evaluate his predictions upon completion of experiments to find out new ways to use familiar learnings.

use wire stripper, compass, magnets, electromagnets, prediction sheets, and galvanometers.

understand how circuits function by wiring and drawing simple and complex circuits, using standard symbols.

invent or improvise materials needed for experiments.

predict what will happen in a standard-symbol diagram of circuits and check his prediction by constructing the circuit.

chart and graph experiment results to show comparisons of various combinations of wire, bulbs, and batteries.

construct a simple battery and bulb.

develop standards for comparison. (For example, brightness of bulbs)

Phase V PHYSICAL SCIENCE

Subconcepts	Suggested Units
	Kitchen Physics Sink or Float Dipping Birds
	Pendulums

Behavioral Objectives

perform experiments to isolate and explore the nature of some properties of liquid.

identify these properties and formulate ideas about them.

observe, formulate questions, make predictions, design and perform experiments, collect and analyze data.

recognize and correct earlier misconceptions.

assemble and use simple equipment, such as a balance, tensiometer, and hydrometer.

assemble equipment by using directional worksheets.

accept uncertainty and some unresolvable questions.

make comparisons that require the use of balances and the measurement of volumes.

use balances to check his notions of relative weights of objects in the classroom.

observe that the balance act is dependent on the properties of the objects which are being weighed.

order objects in his environment according to their weight.

sort objects which float and sink by changing a variable.

devise ways to make objects that float, sink and those that sink, float.

---

identify and analyze simple properties of pendulums.

recognize objects in his environment that demonstrate the principles of pendulums.

demonstrate the loss of motion and transfer of energy through the use of pendulums.

construct pendulums and devise experiments that might offer solutions to problems.

make measurements, using standard units of measure.

devise his own measurement tools for comparison.

Subconcepts	Suggested Units
	Mystery Powders
	Gases and Airs
	Balloons
	Ice Cubes Heating and Cooling Colored Solutions Teacher-Devised Units

Phase V PHYSICAL SCIENCE

Behavioral Objectives

identify properties of various substances by taste, smell, touch, and comparison with known substances.

use indicators to detect the presence of certain substances such as heat, iodine, and vinegar.

record and chart the results of experiments with various substances.

identify the composition of some mixtures by using various indicators.

conduct experiments involving the use of controls.

identify variables which are manipulated and those which are constant.

prepare and collect gases.

identify properties of gases.

devise tests which enable him to distinguish between common gases.

identify and demonstrate the effect of different surrounding atmospheres on the weight of gases.

determine sources of carbon dioxide.

use histograms, charts, and tables to record weights of gases and liquids.

construct simple weighing devices.

* exercise intuitive thinking as a result of his experience with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Subconcepts

Supplementary Units: Phase V

Supplemental units which meet behavioral objectives for this phase. These units may be used separately or in conjunction with other units.

- Elementary Science Study
  - Whistles and Strings
  - Mirror Cards
  - Attribute Games
  - Creature Cards
  - Tangrams
  - Structures
  - The Chemistry of a Lemon
  - The Chemistry of Soap
  - The Last Tree Bird
  - Plants Are Like That
  - Puttering with Paper
  - Rocks and Rills
  - Take a Balloon
- Teacher-Devised Units

Phase V PHYSICAL SCIENCE

Behavioral Objectives

Concept C - Living things are interdependent with one another and with their environment.

D - A living thing is the product of its heredity and environment.

E - Living things are in constant change.

Subconcepts	Suggested Units
C - 1 Living things depend on their environment for the conditions of life.	Elementary Science Study Bones
C - 2 Living things capture matter from the environment and return it to the environment.	
C - 3 The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.	
C - 4 All living things depend on a continuous supply of oxygen.	
D - 1 Living things are related through possession of common structure.	
D - 2 A living thing reproduces itself and develops in a given environment.	
D - 3 The cell is the unit of structure and function; a living thing develops from a single cell.	
D - 4 Cells are specialized for different functions.	
D - 5 Cells reproduce themselves.	

Behavioral Objectives

The child should demonstrate the ability to:

identify and classify different kinds of bones according to their function and structure.

associate bones and the size of animals from which they originated.

use scientific names of bones.

assemble a skeleton from a pile of bones.

make precise verbal descriptions of bones and their functions.

make two-dimensional drawings of three-dimensional objects.

devise projects and experiments on assembling bones into skeletons.

prepare bones (cooking) for assembling.

dissect a small animal (fish).

identify bones from owl pellets.

recognize the function and location of joints in humans and animals.

manipulate bones and devise experiments that lead to tentative conclusions about bone structure and function.

make gross recognition of various bone structures through the use of x-rays.

identify and classify bones (mammals, birds, reptiles, etc.).

recognize the connection between an animal's diet and its tooth structure.

Phase V LIFE SCIENCE

Subconcepts	Suggested Units
E - 1 Living things grow and develop in different environments.	Small Things
E - 2 The environment is in constant change.	
E - 3 Living things have changed over the ages.	
E - 4 The adaptation of an animal to its environment can be understood by relating bone structure to the function served.	
E - 5 The single-celled organisms that developed in the early seas gave rise to the many-celled organisms of later eras. Adaptation to the environment produced more complex structures.	
	Pond Water Euglena
	Eggs and Tadpoles Butterflies Mosquitoes

Phase V LIFE SCIENCE

Behavioral Objectives

use a simple and a compound microscope.

prepare a specimen for viewing.

use stains to assist in distinguishing cell structure.

investigate and compare cell structures and their functions.

examine a variety of living and non-living substances and decide which ones are composed of cells.

assemble and use a simple balance.

measure amounts of water contained in some materials.

compare and contrast experimental findings with those of his classmates.

determine how much growth of yeast cells has occurred during a specific time period.

---

identify and describe individual animals and plants that live in pond water.

devise experiments that test the effect of various stimuli on pond-water life and report his findings accurately.

recognize the complicated interaction of living things such as demonstrated by pond-water organisms.

observe and identify stages in life cycles of various organisms.

---

ask questions that he can answer from his own observations.

recognize the relationship of the growing tadpole, frog, or insect to its environment.

Phase V LIFE SCIENCE

Subconcepts

Suggested Units

Mealworms

Microgardening

Crayfish

Farmington Unit on Plants

Behavioral Objectives

prepare slides for use under the microscope and use the process of staining.

observe and record the structure, habits, and locomotion of the organism.

conduct experiments exploring the response of an organism to various stimuli.

---

recognize the complicated interaction of living things such as demonstrated by molds.

observe and grow molds and bacterial colonies.

recognize that molds and bacteria are extremely small microorganisms that reproduce and carry on all the life processes.

examine the details of mold structure and make comparisons among different kinds of molds.

set up experiments, sorting variables and using controls, to show the factors that influence the growth of molds.

---

recognize that a social order exists with crayfish.

infer that a social order exists with other animals.

observe feeding habits of crayfish and distinguish parts used in eating.

design experiments to test behavior of crayfish.

identify the life cycle of crayfish.

---

identify similarities and dissimilarities in sizes and shapes of leaves, stems, and roots.

recognize differences in color, shades, and patterns.

Subconcepts	Suggested Units
	Farmington Unit on Plants (continued)

Behavioral Objectives

recognize differences in texture, such as: rough, smooth, moist, dry, fuzzy, prickly, slippery, sticky.

recognize differences in odor and taste (caution).

classify regularities or sets of leaves, stems, and roots.

use standard units and tools of measurement.

use a self-designed system of measurement.

use units of measurement to measure space/time relationships in leaves, stems, and roots.

make oral, written, and graphic descriptions about leaves, stems, and roots.

identify the subjectivity and limitations of data.

make tentative conclusions about leaves, stems, and roots based on strong circumstantial evidence.

identify problems related to leaves, stems, and roots and set up procedures to test inferences.

identify results in support or rejection of hypotheses about leaves, stems, and roots.

recognize the need to modify testing procedures when required.

make predictions based on objective data and testing of leaves, stems, and roots.

apply processes and concepts to unfamiliar situations.

observe similarities and dissimilarities in the different types of life processes.

identify the parts of a plant where the life processes occur.

classify plants in terms of similarities and differences in life processes and structure.

use measuring units and tools to evaluate life processes.

Subconcepts	Suggested Units
	Science Curriculum Improvement Study Food (Energy) Transfer (in preparation)
	MINNEMAST Living Things In Field and Classroom
	Teacher-Devised Units

Phase V LIFE SCIENCE

Behavioral Objectives

make accurate oral, written, and graphic descriptions of life processes.

identify the subjectivity and limitations of data concerning life processes.

make tentative conclusions about life processes based on strong circumstantial evidence.

identify problems related to life processes and set up procedures to test inferences.

identify the results of testing for life processes in support or rejection of hypotheses.

recognize the need to modify testing procedures when necessary.

make predictions based on objective data and testing of life processes.

apply processes and concepts to unfamiliar areas.

* exercise intuitive thinking as a result of his experiences with indivdualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Concept F - The universe is in constant change.

Subconcepts

F - 1 There are regular movements of the earth and the moon.

F - 2 There are seasonal and annual changes within the solar system.

F - 3 Motion and path of celestial bodies are predictable.

F - 4 Bodies in space (as well as their matter and energy) are in constant change.

Suggested Units

Elementary Science Study Project
Charting the Universe

The Universe in Motion

Phase V EARTH SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

estimate size and distance without the use of direct measurement.

make a scale drawing as a representation of a real object or objects; i.e., the solar system.

develop his own system for measuring distance.

use a compass, protractor, range finder, and telescope.

solve for an unknown circumference, diameter, or radius.

sight objects from two fixed points.

estimate the daily motion of the sun, moon, and planets.

recognize that everything in the universe moves.

locate an object or a specific point on the earth or in space, using compass direction and angular height.

plot the motions of the moon and the sun.

recognize some of the major constellations.

use a star map and gnomen.

draw ellipses.

measure in astronomical units, charts, and tables.

state and demonstrate laws of planetary motion.

Subconcepts

Suggested Units

The Universe in Motion (continued)

Elementary Science Study
Optics

Elementary Science Study
Mapping
Outdoor Mapping

Elementary Science Study
Where Is the Moon?

Behavioral Objectives

state and demonstrate the differences between straight-line motion and curved motion.

identify the colors of a continuous spectrum and an absorption spectrum.

describe the sun's function and structure.

identify behaviors of light and demonstrate their effect on astronomical phenomena by use of the spectroscope.

describe the characteristics of a star.

---

recognize and analyze properties of light by direct experiment.

recognize the interaction of light with transparent and reflective objects.

---

describe his environment through the use of symbols, grids, and landmarks.

map various land features such as hills, streams, and cliffs.

represent three dimensions in two-dimensional form.

show the relative positions of objects in space.

estimate shape and size of objects in his environment.

make scale drawings.

---

observe and record changes in spacial relationships of light and shadows; moon, planets, sun, and earth.

observe that there is an order and regularity of the stars, planets, sun, and moon.

record the movements of the moon, using as reference points familiar objects in his environment.

Subconcepts

Suggested Units

Elementary Science Study
   Rocks and Charts

Elementary Science Study
   Snowflakes

Scientific Research Association
   Earth's Atmosphere Laboratory
   Weather and Climate Laboratory
   Solar System Laboratory

Talcott Mountain Science Center
   Astronomy
   Geology
   Meteorology

Children's Museum Planetarium

Teacher-Devised Units

Phase V EARTH SCIENCE

Behavioral Objectives

observe and classify rocks.

communicate observations by way of charts, graphs, and worksheets, as well as make precise verbal descriptions.

---

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase E PHYSICAL SCIENCE

Concept A - When energy changes from one form to another, the total amount of energy remains unchanged.
B - When matter changes from one form to another, the total amount of matter remains unchanged.

Subconcepts

A - 1 Energy can change from one form to another.

A - 2 A loss or gain of energy affects molecular motion.

A - 3 Energy must be applied to produce an unbalanced force, resulting in motion or change of motion.

A - 4 The amount of energy gotten out of a machine does not exceed the energy put into it.

A - 5 The energy gotten out of moving electrons is never greater than the energy put into making electrons move through a circuit.

A - 6 A transfer of electrons from one object to another gives them potential energy; when the electrons move, they have kinetic energy.

B - 1 In chemical change, atoms react to produce change in the molecules.

B - 2 In chemical or physical changes, the total amount of matter remains unchanged.

B - 3 A loss of matter is a gain in energy. The sum of the matter and energy remains constant.

Suggested Units

Science Curriculum Improvement Study
  Electricity (In preparation)
  Gravitation (In preparation)
  Periodic Motion (In preparation)

Elementary Science Study
  Batteries and Bulbs

Phase E PHYSICAL SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

---

use what he has already learned to make predictions.

investigate at his own rate in the direction dictated by the materials and by the limits of his imagination.

make generalizations that come out of his actual experience with the materials. (For example, a coil of wire in a complete electrical circuit acts as a magnet.)

check his experiments, compare, discuss results, and propose explanations.

evaluate his predictions upon completion of experiments to find out new ways to use familiar learnings.

use wire stripper, compass, magnets, electromagnets, prediction sheets, and galvanometers.

understand how circuits function by wiring and drawing simple and complex circuits, using standard symbols.

invent or improvise materials needed for experiments.

predict what will happen in a standard-symbol diagram of circuits and check the prediction by constructing the circuit.

chart and graph experiment results to show comparisons of various combinations of wire, bulbs, and batteries.

construct a simple battery and bulb.

develop standards for comparison (for example, brightness of bulbs).

Subconcepts

Suggested Units

Kitchen Physics
Sink or Float
Dipping Birds

Pendulums

PHASE E PHYSICAL SCIENCE

Behavioral Objectives

perform experiments to isolate and explore the nature of some properties of liquid.

identify these properties and formulate ideas about them.

observe, formulate questions, make predictions, design and perform experiments, collect and analyze data.

recognize and correct earlier misconceptions.

assemble and use simple equipment, such as a balance, tensiometer, and hydrometer.

assemble equipment by using directional worksheets.

accept uncertainty and some unresolvable questions.

make comparisons that require the use of balances and the measurement of volumes.

use balances to check his notions of relative weights of objects in the classroom.

observe that the balance act is dependent on the properties of the objects which are being weighed.

order objects in his environment according to their weight.

sort objects which float and sink by changing a variable.

devise ways to make objects that float, sink and those that sink, float.

---

identify and analyze simple properties of pendulums.

recognize objects in his environment that demonstrate the principles of pendulums.

demonstrate the loss of motion and transfer of energy through the use of pendulums.

construct pendulums and devise experiments that might offer solutions to problems.

make measurements, using standard units of measure.

devise his own measurement tools for comparison.

Subconcepts

Suggested Units

Optics

Gases and Airs

Balloons

Teacher-Devised Units

Supplementary Units: Phase E

Supplemental units which meet behavioral objectives for these phases. These units may be used separately or in conjunction with other units.

Elementary Science Study
- Balancing
- Mobiles
- Whistles and Strings
- Mirror Cards
- Attribute Games

Phase E PHYSICAL SCIENCE

Behavioral Objectives

recognize and analyze properties of light by direct experiment.

recognize the interaction of light with transparent and reflective objects.

---

conduct experiments involving the use of controls.

identify variables which are manipulated and those which are constant.

prepare and collect gases.

identify properties of gases.

devise tests which enable him to distinguish between common gases.

identify and demonstrate the effect of different surrounding atmospheres on the weight of gases.

determine sources of carbon dioxide.

use histograms, charts, and tables to record weights of gases and liquids.

construct simple weighing devices.

---

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase E PHYSICAL SCIENCE

Subconcepts

Supplementary Units: Phase E

Elementary Science Study (continued)
- Creature Cards
- Tangrams
- Structures
- The Chemistry of a Lemon
- The Chemistry of Soap
- The Last Tree Bird
- Plants Are Like That
- Puttering with Paper
- Rocks and Rills
- Take a Balloon

Teacher-Devised Units

Phase E PHYSICAL SCIENCE

Behavioral Objectives

Concept C - Living things are interdependent with one another and with their environment.
D - A living thing is the product of its heredity and environment.
E - Living things are in constant change.

Subconcepts

C - 1 Living things capture matter from the environment and return it to the environment.

C - 2 The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.

C - 3 Living things are adapted by structure and function to their environment.

C - 4 Bacteria and plants without chlorophyll depend on other organisms for their food.

D - 1 A living thing reproduces itself and develops in a given environment.

D - 2 The cell is the unit of structure and function; a living thing develops from a single cell.

D - 3 The characteristics of a living thing are laid down in a genetic code.

E - 1 Living things grow and develop in different environments.

E - 2 The environment is in constant change.

E - 3 Living things have changed over the ages.

E - 4 Changes in the genetic code produce changes in living things.

Suggested Units

Science Curriculum Improvement Study
Ecosystem (In preparation)
Natural Selection (In preparation)

Elementary Science Study
Small Things

Microgardening

Phase E LIFE SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

---

use a simple and a compound microscope.

prepare a specimen for viewing.

use stains to assist in distinguishing cell structure.

investigate and compare cell structures and their functions.

examine a variety of living and non-living substances and decide which ones are composed of cells.

assemble and use a simple balance.

measure amounts of water contained in some materials.

compare and contrast experimental findings with those of his classmates.

determine how much growth of yeast cells has occurred during a specific time period.

---

recognize the complicated interaction of living things such as demonstrated by molds.

observe and grow molds and bacterial colonies.

recognize that molds and bacteria are extremely small microorganisms that reproduce and carry on all the life processes.

Subconcepts	Suggested Units
	Elementary Science Study Microgardening (continued)
	Pond Water Euglena
	Eggs and Tadpoles Butterflies Mosquitoes
	Crayfish
	Behavior of Mealworms

Phase E LIFE SCIENCE

Behavioral Objectives (continued)

examine the details of mold structure and make comparisons among different kinds of molds.

set up experiments, sorting variables and using controls, to show the factors that influence the growth of molds.

---

identify and describe individual animals and plants that live in pond water.

devise experiments that test the effect of various stimuli on pond-water life and report his findings accurately.

recognize the complicated interaction of living things such as demonstrated by pond-water organisms.

observe and identify stages in life cycles of various organisms.

---

ask questions that he can answer from his own observations.

recognize the relationship of the growing tadpole, frog, or insect to its environment.

---

recognize that a social order exists with crayfish.

infer that a social order exists with other animals.

observe feeding habits of crayfish and distinguish parts used in eating.

design experiments to test behavior of crayfish.

identify the life cycle of crayfish.

---

prepare slides for use under the microscope and use the process of staining.

observe and record the structure, habits, and locomotion of the organism.

conduct experiments exploring the response of an organism to various stimuli.

Subconcepts

Suggested Units

Bones

Farmington Unit on Plants

Phase E LIFE SCIENCE

Behavioral Objectives

identify and classify different kinds of bones according to their function and structure.

associate bones and the size of animals from which they originated.

use scientific names of bones.

assemble a skeleton from a pile of bones.

make precise verbal descriptions of bones and their functions.

make two-dimensional drawings of three-dimensional objects.

devise projects and experiments on assembling bones into skeletons.

prepare bones (cooking) for assembling.

dissect a small animal (fish).

identify bones from owl pellets.

recognize the function and location of joints in humans and animals.

manipulate bones and devise experiments that lead to tentative conclusions about bone structure and function.

make gross recognition of various bone structures through the use of x-rays.

identify and classify bones (mammals, birds, reptiles, etc.).

recognize the connection between an animal's diet and its tooth structure.

---

identify similarities and dissimilarities in sizes and shapes of leaves, stems, and roots.

recognize differences in color, shades, and patterns.

recognize differences in texture, such as: rough, smooth, moist, dry, fuzzy, prickly, slippery, sticky.

Subconcepts

Suggested Units

Farmington Unit on Plants (continued)

Phase E LIFE SCIENCE

Behavioral Objectives

recognize differences in odor and taste (caution).

classify regularities or sets of leaves, stems, and roots.

use standard units and tools of measurement.

use a self-designed system of measurement.

use units of measurement to measure space/time relationships in leaves, stems, and roots.

make oral, written, and graphic descriptions about leaves, stems, and roots.

identify the subjectivity and limitations of data.

make tentative conclusions about leaves, stems, and roots based on strong circumstantial evidence.

identify problems related to leaves, stems, and roots and set up procedures to test inferences.

identify results in support or rejection of hypotheses about leaves, stems, and roots.

recognize the need to modify testing procedures when required.

make predictions based on objective data and testing of leaves, stems, and roots.

apply processes and concepts to unfamiliar situations.

observe similarities and dissimilarities in the different types of life processes.

identify the parts of a plant where the life processes occur.

classify plants in terms of similarities and differences in life processes and structure.

use measuring units and tools to evaluate life processes.

make accurate oral, written, and graphic descriptions of life processes.

identify the subjectivity and limitations of data concerning life processes.

Subconcepts

Suggested Units

Farmington Unit on Plants (continued)

MINNEMAST
  Living Things in Field and Classroom

Teacher-Devised Units

Phase E LIFE SCIENCE

Behavioral Objectives

make tentative conclusions about life processes based on strong circumstantial evidence.

identify problems related to life processes and set up procedures to test inferences.

identify the results of testing for life processes in support or rejection of hypotheses.

recognize the need to modify testing procedures when necessary.

make predictions based on objective data and testing of life processes.

apply processes and concepts to unfamiliar areas.

---

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

---

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

Phase E EARTH SCIENCE

Concept F - The universe is in constant change.

Subconcepts

F - 1 There are daily changes on earth.

F - 2 There are regular movements of the earth and the moon.

F - 3 There are seasonal and annual changes within the solar system.

F - 4 The motion and path of celestial bodies are predictable.

F - 5 Bodies in space (as well as their matter and energy) are in constant change.

F - 6 Nuclear reactions produce the radiant energy of stars, and consequent change.

Suggested Units

Elementary Science Study Project
The Universe in Motion

Charting the Universe
The Message of Starlight
The Life Story of a Star

Phase E EARTH SCIENCE

Behavioral Objectives

The child should demonstrate the ability to:

estimate the daily motion of the sun, moon, and planets.

recognize that everything in the universe moves.

locate an object or a specific point on the earth or in space, using compass direction and angular height.

plot the motions of the moon and the sun.

recognize some of the major constellations.

use a star map and gnomen.

draw ellipses.

measure in astronomical units, charts, and tables.

state and demonstrate laws of planetary motion.
state and demonstrate the differences between straight-line motion and curved motion.
identify the colors of a continuous spectrum and an absorption spectrum.

describe the sun's function and structure.

identify behaviors of light and demonstrate their effect on astronomical phenomena by use of the spectroscope.

describe the characteristics of a star.

estimate size and distance without the use of direct measurement.

make a scale drawing as a representation of a real object or objects; i.e., the solar system.

develop his own system for measuring distance.

Subconcepts	Suggested Units
	Elementary Science Study Where Is the Moon?
	Optics
	Mapping Outdoor Mapping

Phase E EARTH SCIENCE

Behavioral Objectives

use a compass, protractor, range finder, and telescope.

solve for an unknown circumference, diameter, or radius.

sight objects from two fixed points.

---

observe and record changes in spacial relationships of light and shadows; moon, planets, sun, and earth.

---

record the movements of the moon, using as reference points familiar objects in his environment.

recognize and analyze properties of light by direct experiment.

recognize the interaction of light with transparent and reflective objects.

observe that there is an order and regularity of the stars, planets, sun, and moon.

---

describe his environment through the use of symbols, grids, and landmarks.

map various land features such as hills, streams, and cliffs.

represent three dimensions in two-dimensional form.

show the relative positions of objects in space.

estimate shape and size of objects in his environment.

make scale drawings.

Subconcepts	Suggested Units
	Elementary Science Study Snowflakes
	Scientific Research Associates Earth's Atmosphere Laboratory Weather and Climate Laboratory Solar System Laboratory
	Talcott Mountain Science Center Astronomy Geology Meteorology
	Children's Museum Planetarium
	Teacher-Devised Units

Phase E EARTH SCIENCE

Behavioral Objectives

* exercise intuitive thinking as a result of his experiences with individualized science materials.

* solve problems and apply familiar learnings to unfamiliar situations through analytical thinking.

* These behavioral objectives are appropriate for all phases and for all units. They are the key objectives for supplemental units where there is an absence of specific conceptual development.

DESCRIPTION OF UNITS

Units under each publisher source are listed alphabetically.

A Process Approach

The Process Approach places the student in an active and dynamic role of investigating science -- using the processes of the scientist. Through the systematic use of these processes in the primary grades, the children become equipped for more complex science education in subsequent grades.

Primary Grades - - - - - observing, classifying, measuring, inferring, predicting, interpreting, hypothesizing (Basic skills)

Middle and Upper Grades - formulating hypotheses, controlling variables, interpreting data, defining operationally, and experimenting. Throughout the intermediate grades, the manuals enlarge on the process skills by means of exercises which become progress. (Complex, integrated skills)

The planned teaching sequence of process skills is an important element in the overall curriculum design of the project. Each unit is designed to provide a maximum of pupil involvement. In most lessons each child works with his own materials and equipment.

Materials Needed:

All materials for this unit are available from Xerox Corporation.

Astronomy

These units can be used in conjunction with Talcott Mountain Science Center.

Book 1 - Charting the Universe

This unit deals chiefly with the measurement of size and distances of astronomical objects so that a static-snapshot model of the universe can be developed. Charting the Universe should be used with more gifted children.

Book 2 - The Universe in Motion

The Universe in Motion is concerned with how celestial bodies move in space and how these motions are observed by astronomers. The unit should be used with more gifted children.

Book 4 - The Message of Starlight

This unit turns to elements of spectroscopy and the analysis of light as an essential clue to understanding astronomical phenomena. The unit should be used with more gifted children.

Book 5 - The Life Story of a Star

The Life Story of a Star treats the interiors of stars, their energy sources, and their evolution. The unit should be used with more gifted children.

Materials Needed:

Teacher's Guide and Student's Booklet are available from the Elementary Science School Project.

Attribute Games

This unit is concerned with the development of thinking skills in children. It provides an opportunity for children to deal with problems involving classification and the relationships between classes. Such experiences can help provide the familiarity and the skill necessary for solving problems in science, social studies, mathematics, or other subjects.

These activities need not involve an entire class at once, nor need they occupy a class for an entire period. Small groups or individual children can use these during the science period or at any other time during the day.

The same materials are used, though in different ways, from kindergarten through eighth grade and beyond. Many of the activities prove challenging to adults.

The unit is divided into four units: A Blocks, Color Cubes, People Pieces, and Creature Cards. A Blocks provide the learner with experiences in shifting from the whole to its parts and back again. The materials are bounded by their defining attributes, which have a high degree of contrast. Bright colors, distinct shapes, and obvious size differences emphasize the uniqueness of each of the A Blocks, while they also make it possible to group materials into sets having properties in common.

Color Cubes involve six values of only one attribute.

People Pieces are another set of blocks with attributes which are not so easy to distinguish.

Creature Cards, drawings on paper, introduce a large variety of values for children to discover.

The units are stimulating and challenging and provide excellent supplemental or enrichment activities.

Materials Needed:

Teacher's Guide
Materials
Problem Cards
Stickers

The Teacher's Guide and materials for this unit are available from Webster Division, McGraw Hill.

Materials are also available from Selective Educational Equipment.

ESS

The Balance Book

The unit describes how young children can explore and gain an understanding of the world of balance and weight by balancing things--large and small, heavy and light, on the playground and in the classroom. The purpose of the exploration is to acquaint children with this world at a time in their development when hand and manipulative learnings are most important. Equal-arm balances, walking boards, four-foot balance boards, and an assortment of materials and objects, from crayons to people, provide the opportunity.

Materials Needed:

Teacher's Guide
Teacher's Kit
Six-Student Kit

The Teacher's Guide and materials are available from Webster Division, McGraw Hill.

Kits and separate items from each kit are available from Selective Educational Equipment.

ESS

Balloons

This unit provides children with an opportunity to prepare and collect gases, to discover some of their properties, to examine tests which enable one to distinguish some of the common gases from one another, and to see the effect of different surrounding atmospheres on the "weight" of gases.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill. Materials are available from Selective Educational Equipment.

Batteries and Bulbs

Batteries and Pulbs is an introduction to the study of electricity and magnetism. There are many experiments done with simple equipment. The unit consists of four books.

Book 1 - Circuits I

The unit basically introduces batteries and simple circuit-making.

Book 2 - Circuits and Magnets

Children are introduced to some of the properties of magnets and to some of the relationships between magnets and circuits.

Book 3 - Circuits II

The unit involves work with more complex circuits, Nichrome wire, and other batteries. Investigations by children enliven suggested experiments.

Book 4 - Guide to Books on Electrical Circuits and Magnets for Elementary Schools

This guide contains a complete listing of children's books that will enrich the Bulbs and Batteries unit. Listed alphabetically by title, they include survey books, experimental books, and historical and biographical books.

Materials Needed:

Teacher's Guide (one each of four guides)
Class Kit

Available from Webster Division, McGraw Hill.

The Class Kit and separate items from the kit are available from Selective Educational Equipment.

ESS

Bones

In the course of this unit the children will learn many facts about bones, particularly the skeletal system. Bones gives children a chance to become familiar with a variety of bones, to notice similarities and differences among them, and to experience the satisfaction of making skeletons. Bones provides possible activities and leaves day-to-day procedures to one's discretion.

Materials Needed:

Teacher's Guide
Bone Picture Book
How to Make a Chicken Skeleton
Picture Packet for Bones
Class Kit for Bones
Cat Skeleton
Mink Skeleton
Rabbit Skeleton
Trays for Bones
Mystery Bones
Film Loops
    X-Ray Motion Pictures: Head and Neck
    X-Ray Motion Pictures: Shoulder
    X-Ray Motion Pictures: Knee and Elbow
    X-Ray Motion Pictures: Hand
    X-Ray Motion Pictures: Foot

All materials are available from Webster Division, McGraw Hill. Film loops, kits, and separate items from kits are available from Selective Educational Equipment.

ESS

Brine Shrimp

Brine Shrimp is a simple unit exploring the living habits and life cycle of a small salt-lake crustacean. By raising brine shrimp, watching their development, and performing simple experiments with them, students can become acquainted with some of the problems confronted by living organisms.

Materials Needed:

Teacher's Guide
Film Loops
    Brine Shrimp I
    Brine Shrimp II

Available from Webster Division, McGraw Hill.

ESS

Budding Twigs

This unit gives children an opportunity to examine in the classroom the structure of twigs and the development of buds forced into bloom out of season. Through observation and dissection, children become aware of the varieties and complexities of plant construction. As the study progresses, they design experiments to answer their questions.

Budding Twigs has been used primarily with children ages 8-12. It is suggested that these activities be planned as a late winter and early spring unit.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Butterflies

Butterflies deals with the life history of a butterfly, demonstrating the endless cycle of birth, growth, and death, and the continuity of life from one generation to the next. The dramatic transitions a butterfly makes from one stage to another help sustain high interest even in very young children. Since butterflies are easy to handle and raise, it is hoped that each child will have his own creature to study in school and carry home at night, thus assuming some personal responsibility for its survival. This unit helps the child observe and question, two important aspects of scientific inquiry.

Materials Needed:

Teacher's Guide
Film: Life of a Butterfly (16 mm.,silent,color, 18 min.)
Film Loops: Black Swallowtail Butterfly
    Egg-Laying, Hatching, and Larvae
  Black Swallowtail Butterfly
    Larval Molt
  Black Swallowtail Butterfly
    Preparing to Pupate I
  Black Swallowtail Butterfly
    Preparing to Pupate II
  Black Swallowtail Butterfly
    Pupal Molt
  Black Swallowtail Butterfly
    Emergence

The Teacher's Guide and materials for this unit are available from Webster Division, McGraw Hill.

ESS

Cardboard Carpentry

Cardboard Carpentry is really a resource for teachers showing the myriad of constructions that can be made for the classroom out of tri-wall cardboard. Chairs, boats, houses, portable blackboards, carts, shelves, and wagons, to name just a few, can be made simply and inexpensively by enthusiastic teachers.

Materials Needed:

Manual is available from Elementary Science Study, Educational Development Center, Inc.

Tools for use with this unit will be available in the fall of 1968 from Selective Educational Equipment.

ESS

Changes

Children predict what things will change when left by themselves. They also consider things that will not change. Children are able to verify their predictions through observation; e.g., food becomes garbage and wet metal rusts. It is hoped that children will develop their own sense of biological and physical changes.

Materials Needed:

Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Colored Solutions

This unit attempts to introduce children to some phenomena which will lead them to experiments associated with the ideas of density and the layering of liquids. Various concentrations of salt solutions identified by color are used.

Materials Needed:

Teacher's Guide and materials are available from Webster Division, McGraw Hill.

Materials are available from Selective Educational Equipment.

ESS

Crayfish

Through observation children will become familiar with the habits and habitat of crayfish. Each child will learn, from what he sees, how the crayfish feels, and will discover through experiments the ways of life of crayfish. The care of crayfish in regard to handling, housing, and feeding is listed for the teacher. Since each child will "own" his own crayfish, commercial suppliers are listed in the Appendix.

Materials Needed:

Teacher's Guide
Live Crayfish

See Appendix for live crayfish suppliers. Connecticut Valley Biological Supply Company is the best local supplier. Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

The Curious Gerbils

This small booklet on caring for gerbils can be used either by the teacher for motivating class discussions or by interested students. Feeding, housing, and reproduction are included, as well as games gerbils can play!

Materials Needed:

The booklet is available from Webster Division, McGraw Hill. How to Raise and Train Gerbils is available from Selective Educational Equipment.

ESS

Dipping Birds

This unit is to be used after Kitchen Physics. It capitalizes on phenomena of absorption and capillarity and the equilibrium which may be reached between these processes in blotters and other absorbent material. There is an accurate description of how to construct a "dipping bird."

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Drops, Streams, and Containers

This is a guide to play and investigation with liquids. Children examine flow, drop formation, and other properties of water, soapy water, oil, and other available liquids, using a variety of containers, tubes, and surfaces.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Eggs and Tadpoles

The purpose of this unit is to encourage an interest in all living things through exploration of frog eggs and tadpoles. Much of the purpose is achieved through observation. In the classroom children discover for themselves the life cycle of the frog.

Materials Needed:

Teacher's Guide
Film Loops: Frog Egg I
    First Cell Division to Early Neural Fold
  Frog Egg II
    Development of Body Regions
  Frog Egg III
    Continued Development to Hatching
  Frogs: Pairing and Egg-Laying
  Artificial Fertilization of Frog Eggs
  Frogs: Pituitary Preparation
  Tadpoles I
  Tadpoles II

Films: Frog Development: Fertilization to Hatching
    (16 mm., silent, color, 12 min.)
  Frog Development: Hatching Through Metamorphosis
    (16 mm., silent, color, 9½ min.)

The Teacher's Guide, films, and other materials are available from Webster Division, McGraw Hill.

See Appendix for distributors of live frog eggs.

ESS

Euglena

Using the unit as a guide, teacher and children can grow the pond-water organism Euglena quite simply. *Euglena* is intended to follow up the casual viewing they have done in the *Small Things* unit. It is essential for children to have worked with microscopes before beginning *Euglena*. Growing and examining cultures is an important part of this unit.

Materials Needed:

Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Gases and Airs

Gases and Airs is a laboratory investigation into some properties of gases and the interaction of air with "things" in the environment. The activities, which involve the use of controls, are designed to acquaint children with an area of science and a scientific approach to solving problems. Some activities included in *Gases and Airs* are the "burning candle" and "egg-and-bottle" experiments.

This unit is suggested for use with children ages 9-12.

Materials Needed:

Teacher's Guide
Teacher's Kit
Six-Student Kit
Worksheets

Film Loops: Candle Burning I
Candle Burning II
Candle Burning Techniques
The Mouse and the Candle

The Teacher's Guide, films, and other materials are available from Webster Division, McGraw Hill.

Film loops, kits, and separate items from each kit are available from Selective Educational Equipment.

ESS

Geo Blocks

Geo Blocks are a set of hardwood blocks with a range of sizes and shapes designed to give children experience with geometric shape and also to stimulate their interest in linear measure, surface area, and volume relationships. They encourage children to gain experience in manipulating geometric objects -- experience which they can relate to informal interests as well as to academic subjects.

It is recommended that the blocks have a permanent place in the classroom and that children be allowed to work with them during activity periods and in their free time.

Activities include building, counting, making shapes, making slopes, grouping, finding surface area, finding volume, and making rules.

Materials Needed:

The Teacher's Guide and materials for this unit are available from Webster Division, McGraw Hill.

Materials are also available from Selective Educational Equipment.

ESS

Growing Seeds

Children gather and plant small objects, some of which prove to be seeds. As seeds sprout, children can follow through measurement the growth of the plant. Children learn to answer their own questions about growing seeds. Included is a list of materials for Part One--What Are Seeds? What Do They Do? and Part Two--Deciding How Fast Seedlings Grow.

Materials Needed:

Teacher's Guide
Class Kit
Film Loops: Bean Sprouts
Plant Growth Graphing

The Teacher's Guide and materials are available from Webster Division, McGraw Hill.

Film loops, the Class Kit, and separate items from the kit are available from Selective Educational Equipment.

ESS

Heating and Cooling

The developmental teaching is aimed at problems of heat transfer and loss by using various heat sources and materials.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Kitchen Physics

This is a unit drawn from the child's environment. Experiments can travel from school to home and vice versa. The major emphasis is for the child to acquire an awareness of the worldof science matching his level of understanding and operation by using equipment and materials found in today's kitchens.

The subject is approached by studying liquids: how they form puddles and drops; how they fall and break up, are absorbed, evaporate, mix, and dissolve. The student assembles and uses simple equipment.

Materials Needed:

Teacher's Guide
Teacher's Kit
Six-Student Kit
Worksheets
Film Loops: Beading of a Water Column
Water Rise in Blotter Strips of Graded Width
Water Rise in Blotter Strips Exposed and Enclosed

Teacher's Guide, film loops, and other materials are available from Webster Division, McGraw Hill.

Film loops, kits, and separate items from kits are available from Selective Educational Equipment.

ESS

Lights and Shadows

This unit is an illustrated guide for teachers, showing all kinds of experiences children can have with lights and shadows. Activities include the following: drawing shadows, playing shadow tag, performing shadow plays, exploring symmetry, using mirrors and puddles, making silhouettes, using flashlights to form shadows, following sun shadows, and other interesting inventions of both students and teachers which explore appropriate concepts.

Materials Needed:

Teacher's Guide for this unit is available from Webster Division, McGraw Hill.

ESS

Mapping

A map is any symbolic representation, a pattern, a guide, a description. A map can take many forms to transmit its information. Mapping games require children to transfer information from one form or medium to another, or from one person to another. This unit includes perception, estimation, manipulation, and photography.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Mealworms

Parts of the Mealworm unit may be used with 6-,7-, and 8-year-old children as they study living things. The entire unit is most appropriate for 10-, 11-, and 12-year-old students.

Children are given the opportunity to extend their skills of scientific inquiry by studying the behavior of mealworms. Activities range from watching mealworms to controlling variables as children experiment with them.

Materials Needed:

Teacher's Guide
Set of Six Illustrations
Live Mealworms

The Teacher's Guide and illustrations are available from Webster Division, McGraw Hill.

See Appendix for distributors of live mealworms. The Brockton Worm Hatchery is the best local supplier of mealworms.

ESS

Microgardening

Children are introduced to a group of microscopic living things very different from the trees, shrubs, wild flowers, and other plants with which they are familiar. A study of molds through growth and the use of microscopes will help the children gain some appreciation of the importance of molds and other microorganisms in the natural cycle of growth and decay.

Materials Needed:

Teacher's Guide
Illustrated Handbook of Some Common Molds
The Microgardening Cookbook
Class Kit

The Teacher's Guide and materials are available from Webster Division, McGraw Hill.

The Class Kit and separate items from the kit are also available from Selective Educational Equipment.

ESS

Mirror Cards

The materials for this unit are a box of cards and four mirrors. The box of cards contains twenty-one different sets of cards printed with colorful pictures or patterns. The activities are designed for a few children to use at a time. In general, the activities involve trying to match the picture on another card by using a mirror to reflect some part or all of the picture.

The activities provide direct experience with several mathematical and physical concepts. The child will acquire some grasp of what a mirror can and cannot do, and through his early experience he will gain a basis for understanding more geometric concepts, along with concepts of symmetry and optics.

Materials Needed:

The Teacher's Guide and materials for this unit are available from Webster Division, McGraw Hill.

Mirrors are available from Selective Educational Equipment.

ESS

Mobiles

Children of any age explore the laws and problems of balance and weight by making mobile constructions. The activities help to develop a child's awareness of symmetries and motion.

Balancing activities found in the ESS publication *The Balance Book* will enrich the project of making mobiles.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Mosquitoes

Though not written in the usual unit form, but rather as a "working paper," this unit contains information on raising mosquitoes from larvae, ideas and experiments, and descriptions of experiments scientists have performed on mosquitoes. Included is a list of materials needed.

Materials Needed:

The Teacher's Guide for this unit is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Musical Instrument Recipe Book

In preparation

Materials Needed:

The Teacher's Guide will be available from Elementary Science Study, Educational Development Center, Inc.

ESS

Mystery Powders

The unit stresses the identification of "powders" by using senses. Mystery Powders deals with the properties of various substances and the use of indicators in detecting their presence.

Materials Needed:

Teacher's Guide
Class Kit

These materials are available from Webster Division, McGraw Hill.

The kit and separate items from the kit are available from Selective Educational Equipment.

ESS

Optics

Optic activities, in which many different materials are used, acquaint children with the ideas of reflection, refraction, color, and variations of optical path. Experiments with narrow and broad light beams, multiple reflections, colored shadows, and refraction through water lenses are devised and examined.

Optics has been used with children ages 8-12 but is adaptable to all levels.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Outdoor Mapping

Outdoor Mapping helps the child represent the physical world in a variety of ways, chiefly through mapping it. This unit helps a child describe his environment with the help of symbols, grids, and landmarks. This unit should be viewed as supplemental to Mapping.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Pattern Blocks

The unit consists of a set of wooden blocks in the shapes of regular polygons, with each shape painted its own color. Many patterns and designs can be made with the blocks. Pattern design and arithmetic relationships can easily be seen.

Materials Needed:

Teacher's Guide

The Teacher's Guide and blocks are available from Webster Division, McGraw Hill.

Blocks are also available from Selective Educational Equipment.

ESS

Peas and Particles

This is a unit on large numbers and estimations. Its purpose is to give children an understanding of what large numbers mean through informal activities. Although we use large numbers in work or conversation in our daily lives, most of us lack a feeling for "how many" these numbers really represent. Children will learn to round off numbers quickly and will realize that quick estimation frequently will be sufficient to serve as a rough check on detailed calculation.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Pendulums

This unit uses a frame that supports two pendulums. Working in pairs, children compare the effects of length of string, weight of bob, and amplitude. They find out how long to make the strings in order to double, triple, and quadruple the pendulum's period.

Materials Needed:

Teacher's Guide
Eight-Student Kit
Class Kit
Film Loops:
- Sand Pendulum I
  - Drawing Lines, Circles, and Ellipses
- Sand Pendulum II
  - Drawing on a Turntable
- Sand Pendulum III
  - Drawing on a Traveling Table
- Sand Pendulum IV
  - Slowing Down
- Sand Pendulum V
  - Pouring Sand into Soda Straws

The Teacher's Guide, film loops, and other materials are available from Webster Division, McGraw Hill.

Film loops, Class Kit, and separate items from the kit are also available from Selective Educational Equipment.

ESS

Pond Water

The Pond Water unit introduces children to an exciting array of pond life. Using hand lenses and microscopes, they learn, through their own observations, about the tremendous variety of living things existing where they had thought there was nothing. They will begin to understand the complicated interactions of pond life and identify some of the many plants and animals found in ponds.

Materials Needed:

Teacher's Guide
Cards for Pond Water

Available from Webster Division, McGraw Hill.

ESS

Rocks and Charts

This unit is designed to help children look closely at rocks and establish their own ways of comparing them. In addition to learning about rocks, children learn something about setting standards of comparison and designing charts which describe the characteristics of the rocks.

The Elementary Science Study Unit Attribute Games and Problems includes many classification games which can be adapted for use with rocks.

These activities have been tried successfully with children ages 7-12.

Materials Needed:

Teacher's Guide
Class Kit

Available from Webster Division, McGraw Hill. The Class Kit is also available from Selective Educational Equipment.

ESS

Sand

Children explore how sand flows, piles, and slides. They compare sand with dirt, mud, salt, and sugar. They make sand from rocks and try to make rocks from sand. They find ways to sort sand. They use sand to time, count, measure, and weigh. The children also explore color and texture in making pictures, jewelry, and sculpture.

Materials Needed:

The Teacher's Guide for this unit is available from Webster Division, McGraw Hill.

ESS

Sink or Float

The materials in this unit consist of things that sink and things that float in tap water and salt water. Children are given experiences with a variety of solids and liquids, with displacement of volumes of water, and with buoyancy. These experiences provide a framework in the development of the concept of density of solids and liquids.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

ESS

Small Things

Small Things introduces the child to the microscopic world, to the instruments needed to make it accessible, and to the appearance and structure of living and non-living things. The child learns through working with a microscope that some things can be seen only when magnified.

Materials Needed:

Teacher's Guide
Teacher's Kit
Six-Student Kit
Worksheets
Set of 20 Illustrations
The Faithful Eye of Robert Hooke
Film Loops: Paramecium
Euglena
Amoeba
Budding of Yeast Cells
Blepharisma
Stentor
Rotifer
Vorticella
Volvox
Stylonychia
Comparative Sizes of Microscopic Animals

Available from Webster Division, McGraw Hill.

ESS

Snowflakes

This unit uses a recently developed technique of obtaining replicas of snowflakes which are caught as they fall on special plastic cement. The structure, beauty, and symmetry of snowflakes and their relationship to atmospheric conditions at high altitudes are covered in this unit.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Solids and Solutions

This unit involves experimentation with solids that dissolve in water and those that do not. Later activities emphasize what happens to the water level when solids dissolve in water. The unit also includes additional information on the basic elements of crystal-growing.

Materials Needed:

The Teacher's Guide is available from Elementary Science Study, Educational Development Center, Inc.

ESS

Spinning Tables

Spinning Tables is a unit about motion and about the way moving things look when seen from different points of view.

A spinning table is a simple manageable piece of equipment with which a child can explore the paradoxical behavior of things that move in circles.

The basic equipment for each class consists of spinning tables (lazy susans that can be turned by hand) and accessories such as chalk, containers, and clay.

Spinning Tables has been taught with children ages 6-9 but can also be used with older children.

Materials Needed:

The Teacher's Guide and tables are available from Webster Division, McGraw Hill.

Tables are also available from Selective Educational Equipment.

Tangrams

Tangrams consists of pieces and cards. The tangram is an ancient Chinese invention and perhaps the oldest and most enduring of geometric puzzles. It consists of a square divided into seven geometric shapes: two large triangles, a medium triangle, two small triangles, a square, and a rhomboid. A great number of geometric and pictorial arrangements can be made with these pieces.

The activities are designed to develop thinking skills and to develop skill in dealing with basic geometric relationships. Many tangram problems are manageable by preschool children, and yet advanced problems are challenging to most adults.

Each bag of tangram pieces contains four plastic tangrams. Each package of cards contains 121 patterns which children can match by placing the tangram pieces either on or alongside of the cards.

Materials Needed:

Teacher's Guide
Cards
Pieces

The Teacher's Guide and materials for this unit are available from Webster Division, McGraw Hill. Pieces are available from Selective Educational Equipment.

ESS

Where Is the Moon?

Three different kinds of printed materials are supplied with this unit. The first is a Teacher's Guide describing ways of using the materials in the classroom.

A second booklet, Where Was the Moon?, provides a daily picture record of one teacher's observations of the moon from his yard and schoolyard, at the same times of day over a month. It shows how he used his fists to measure the distance between the moon and the sun, and it asks questions that a child can try to answer by making his own predictions. This book is used as a reference, for children will want to make their own picture journals as well.

A third kind of printed material is the reminders. This series of dated notes forms a teaching schedule that children can follow with only minimal direction. Based on the monthly cycles of the moon and the positions of the bright planets, Venus and Jupiter (when one or both can be seen), the reminders give children a day-by-day guide to the sky for a given three-month period.

Where Is the Moon? offers children an informal introduction to the science of observational astronomy. They will see the moon relative to reference points on the earth and in the sky. The moon, Jupiter, Venus, some constellations, and the sun and their apparent motion should become familiar to the children by the end of their study.

Materials Needed:

Teacher's Guide
Student Book
Reminders

Available from Webster Division, McGraw Hill.

ESS

Whistles and Strings

Using simple materials, children construct musical instruments and simultaneously investigate many of the basic sound-making elements of more complex musical instruments. They explore the ways in which pitch, tone quality, and the loudness of sounds can be affected by the physical characteristics of the materials and the way they are manipulated.

Materials Needed:

The Teacher's Guide is available from Webster Division, McGraw Hill.

MINNEMAST

Curves and Shapes

In this unit the students become acquainted with some properties of simple shapes and curves. The study of curves and some of their properties distinguishes simple from non-simple curves. The children participate in activities which show that simple curves may be open or closed; and if they are closed, the curve is the boundary between an inside and an outside region. Finally, the children study four special simple closed curves (the circle, triangle, square, and rectangle) both as independent shapes, such as a square drawn on paper, and as patterns formed by the outlines of objects, such as a dinner plate.

MINNEMAST

Describing and Classifying

Concept of set is introduced. The child knows he has a mother and a father; they become a set (of parents). In this unit the child defines sets by classifying and by listing; he investigates properties and compares sets by one-to-one correspondence. Sets are introduced by objects in the classroom such as blocks, and by biological objects as well. Two points are emphasized:

1) Set remains same after rearrangement.
2) Number of members of a set does not change with rearrangement or substitution.

The concepts of set are basic to both science and mathematics.

MINNEMAST

Describing Locations

Children are introduced to reference frames (see explanation SCIS Relativity) in order to describe the location of an object. This unit provides practice with spatial relations: between, above, right of, left of, north of, south of, east of, west of. To develop these concepts the children give verbal descriptions of the locations of objects in the classroom.

MINNEMAST

Exploring Symmetrical Patterns

The unit strengthens and continues the symmetry concepts introduced in the previous units. The child observes symmetrical patterns in his environment and produces some patterns. Included are activities and tests for three types of symmetry:

1) Repeating Patterns
2) Line Symmetry
3) Rotational, or Turning, Symmetry

MINNEMAST

Introducing Measurement

Since all measurement is essentially a series of comparisons of two objects, the rudimentary comparisons begin in this unit. Length, area, volume, and time durations are compared. First two, then three or more objects are compared. From these comparisons, order is developed. No numerical work is involved.

MINNEMAST

Introducing Symmetry

This unit introduces children to observation of the symmetric patterns that exist in his environment. Observations and manipulations of a variety of actual objects by the children form the bases for most of the lessons. A child will notice the difference in body shape between the butterfly and the moth, for instance.

MINNEMAST

Investigating Systems

Children acquire the idea of "system" as any group of interrelated objects or substances. Children remove objects from a system and observe if it continues to work. Each lesson is introduced by a demonstration with the children participating. Systems studied include:

1) Holding Things Up
2) Rolling Balls
3) Inflating a Balloon
4) A Strange Red Color
5) Systems for Eating
6) Lighting a Bulb
7) Finding New Systems for Lighting a Bulb.

MINNEMAST

Living Things in Field and Classroom

This book serves as a handbook for the teacher in the field of life sciences within the classroom or living things accessible to the classroom. It includes a wide variety of ideas in developing teacher achievement toward instructive experiences. Chapter titles such as "Your Classroom Garden," "Your Classroom Zoo," and "When Children Bring Things In" are valuable aids in beginning a life science room.

MINNEMAST

Measuring with Reference Units

Previous measurement activities are extended to include assigning numbers by the use of various standard units. Measurement involves establishing a ranking order of objects according to the magnitude of some property. Paper clips, corks, and pendulums are used by the children. Later activities include common units such as inches, centimeters, quarts, and seconds. Other activities include work with optical illusions, counting and addition games, distinctions among areas and volumes, and clock and calendar drills.

MINNEMAST

Observing Properties

The children learn to recognize properties of objects by observing with each of their five senses and by performing special tests. Later the children group given objects according to one property and identify each group as a subset. Subsequently, children are asked to classify objects on the basis of two properties, and to identify intersections of subsets that they arrange within closed curves of yarn and on charts. Eventually comes the classification of objects on the basis of three properties.

MINNEMAST

Using Our Senses

Sense experiences involving sight, hearing, smell, taste, and touch increase the child's awareness of his senses as he uses them. The unit first explores properties of familiar objects and then produces "mystery objects."

Watching and Wondering

Kindergarten children are encouraged to watch, to wonder, and to seek their own answers through discovery and testing.

The activities of the unit meet the developmental needs of a child and encourage his natural curiosity. The child explores his classroom, the school building, the playground, and the neighborhood. When he becomes confident of expressing his curiosity freely, he is encouraged to discuss and question his own wonderings. Other lessons discuss, question, and test such topics as the weather and night and day. Study of this unit provides the child with many interesting experiences that expand his powers of observation, his capacity for watching and wondering, and his verbal skills of communication.

Materials Needed:

All Teacher's Guides for MINNEMAST units are available from MINNEMAST. Kits and items from kits are available from Macalaster Scientific Corporation.

Interaction

The *Interaction* unit presents a wide variety of phenomena chosen from many *subject areas* of physical science. Initial contact with these phenomena is afforded through common objects such as a magnet and paper clips, rubber band and a spring, and clay. Each activity is investigated further in exploration and discovery as children work with pulley systems, photographic paper, magnetic compasses, electric circuits, and other systems.

The treatment of the concepts outlined in the guide is of particular interest. These are embraced by the systems concept and interaction concept.

The word "system" refers to a whole made up of parts. This concept is applied whenever a whole, its parts, and their interrelationships must all be kept clearly in mind. Everyone uses the systems concept informally without really being aware that he is using it. Everyone focuses his attention temporarily on parts of his environment and ignores or neglects other parts of it.

Because the matter making up a system may be subdivided, rearranged, or changed in appearance without destroying the entity of the system, it is sometimes difficult to recognize a system after such a change has taken place. (Conservation of Matter)

Matter and energy are of central concern to the physical scientist. He seeks to understand in what ways a system may store energy and how the energy may be transferred as changes occur within a system.

This unit introduces the systems concept and all the subconcepts while children are developing conservation logic.

The interaction concept is employed to provide activities that show how objects have a relationship wherein they jointly produce an effect, which is the result of their action upon each other.

Influence and interaction are abstract ideas that we cannot observe directly. Their effects are what we do observe. It is possible to reverse the reasoning so that we start with the observed effects, the evidence, and identify the interacting objects that were responsible for these effects.

The *Interaction* unit provides lower-level abstractions which offer excellent *first-hand* experiences for higher-level abstractions that students face later on.

Materials Needed:

Teacher's Guide
Complete Kit
Teacher's Replacement Kit
Student's Replacement Kit
Student Activity Booklet

All materials for this unit are available from D. C. Heath and Company.

Life Cycles

Life Cycles is a life science unit devoted to the investigation of ecosystems by focusing on the individual organism. Children observe growth and development, they observe some aspects of reproduction, and they observe death. Seeds can be germinated and the early growth of roots can be observed. Plants can be cared for until they reach maturity and produce flowers and then seeds. Frog eggs can be seen changing into tadpoles and then into adults. Insects such as the fruit fly and the cricket can be observed going through their developmental stages, and as generation follows generation, the ideas of reproduction and death emerge.

Other life cycles aside from those used in the unit can be studied. (See suggested resources.)

Activities include experiences ranging from reproduction and growth to metamorphosis and biotic potential.

Materials Needed:

Teacher's Guide
Complete Kit

All materials are available from D. C. Heath and Company.

Material Objects

The concept that matter exists and has properties is one of the first abstractions the child is able to understand and deal with. Material Objects introduces the child to the fundamental concepts of objects and their properties. It leads him to manipulate, describe, compare, and change the form of samples of metals, woods, plastics, granular materials, liquids, gases, etc.

The main objective of the unit is to teach the child to recognize material objects in his own environment. The objects themselves are to be distinguished from their properties.

While dealing with material objects in this unit, the child will develop various attitudes, abilities, and skills, including habits of careful observation, a vocabulary that is useful in describing objects, methods of recording observations and experiences, and the ability to discriminate fine differences and to recognize broad similarities.

Materials Needed:

Material Objects (1966) Complete Kit (includes Teacher's Guide, activity sheets and equipment for 32 students)
Replacement Kit (for 16 students)
Teacher's Guide
Activity Sheets (1 set, 60 sheets)

All materials are available from D. C. Heath and Company.

Organisms

Organisms is centered on a classroom model of an ecosystem--an aquarium. Some of the basic processes, interactions, and conditions that are characteristic of life are discovered as the children observe events in the aquarium, as they raise and investigate certain questions, and as the teacher and learner initiate activities. Three natural events can be expected to occur in the aquaria:

Birth of guppies and the appearance of snail eggs;

Growth of guppies and young snail eggs;

Death and decay of organisms.

The concept of habitat is introduced to the children to specify the place where an organism lives.

The investigation of algae and their dependence on light provides activities for the unit. The children study feeding and defecation when Daphnia eat algae. The food web is introduced when Daphnia are in turn eaten by guppies.

The children discover that detritus originates from feces and from dead plants and animals. The contribution of detritus to soil fertility is inferred.

Materials Needed:

Teacher's Guide
Equipment Kit

All materials are available from D. C. Heath and Company.

SCIS

Phases of Matter

In this unit the children carry on experiments, try out new concepts as aids in thinking, and apply their reason to what they have observed. They are also expected to exercise their imagination. Through their own experiments the children will study interactions in which new kinds of materials appear while old ones disappear. Thinking about these phenomena, the children find that a new concept, Phase of Matter, is helpful. Thus they can describe and talk about the different phases without having to know more about the materials than they can observe directly. Phases of Matter is a concept central to the unit. The different kinds of observed material are different phases, and each kind of uniform material is a phase. If the materials in any two parts of a system behave differently when treated with the same test substance, they are not the same kind of material- they are not the same phase. Many experiments with liquids and gases are performed.

Materials Needed:

Teacher's Guide
Materials in preparation

All materials for the unit are available from D. C. Heath and Company.

Populations

This unit switches emphasis away from the individual organism and focuses on the population and the community. Other units are easily adaptable to the development of concepts at this level. (See outline.)

A population is the number of the same kind of organisms living and producing in a given area.

The concept of community involves a relationship among different populations that live in the same area. Some animals eat plants; others eat animals. In any community the eaters and the eaten are linked together in a food relationship called a "food chain," which in turn develops into a food web.

Students are provided the opportunity to learn through their own behavior by handling objects and by experimenting with them. They have direct contact with the organisms about which they are learning.

Activities include the study of reproduction within a population and of food relations among different populations. Also included in the unit is the study of Daphnia, hydra, gammarus, planaria, and dragonfly nymphs, as well as various plant populations, and their role in the conceptual development at that level.

Materials Needed:

Teacher's Guide
Materials in preparation

All materials for this unit are available from D. C. Heath and Company.

SCIS

Position and Motion

The unit is designed to follow Relativity. Position and Motion follows a cycle of preliminary exploration, invention of specific concepts related to reference frames, and discovery of the usefulness of the concept. The unit is divided into five parts, each consisting of two to four chapters. The objectives of each part are directed toward increasing the children's understanding of reference frames by involving them in problems where they must use them.

Materials Needed:

Teacher's Guide
Materials in preparation

All materials for this unit are available from D. C. Heath and Company.

SCIS

Relativity

The matters of concern in Relativity are the position and motion of objects. The basic concept is that position and motion of an object can be perceived, described, and recognized only with reference to other nearby objects. These other objects, to which the position and motion are related, are said to form a reference frame, and one speaks of position or motion of the original object relative to the reference frame.

Some topics covered include landmarks, perspective, change of relative position, definition of relative motion, and reporting relative motion. The magic "Mr. O" directs his attention at the objects chosen, he "knows" where all these objects are located, and he always describes their position relative to himself.

Materials Needed:

Teacher's Guide
Complete Kit
Teacher's Replacement Kit
Student's Replacement Kit
Student Activity Booklets

All materials for this unit are available from D. C. Heath and Company.

Systems and Subsystems

The unit, intended to follow Interaction, opens with an extensive review of that unit. Part Two introduces the subsystems concept and includes experiments used by the students. The overall structure of the unit can be viewed as a cycle of exploration, invention, and discovery in relation to the subsystems concept. Particular attention has been paid not only to concept development but also to developing the children's skills in manipulating experimental equipment, in reporting observations, in making predictions, and in comparing data.

The unit presents a wide variety of phenomena chosen from many subject areas of physical science. Children work with varied materials such as: electric circuits, solutions, crystals, liquid and gaseous Freon, thermometers, and Whirly Bird Pendulums.

Materials Needed:

Teacher's Guide
Complete Kit
Student Activity Booklets
Replacement Kit

All materials for this unit are available from D. C. Heath and Company.

Note:

SCIS materials that are in preparation are expected to be commercially available during the school year 1968-69. Trial teaching additions of SCIS units may be purchased directly from SCIS.

Children's Museum (West Hartford)

The museum staff will be glad to work with teachers in helping to develop various types of units for the study of the newest facility--the planetarium. Loans and exhibits are available.

For information see Mr. Russell Harding, Director of Planetarium.

Farmington - Green Plants - Elementary Science

Prepared by Farmington teachers and consisting of organizational procedures and activity cards, the unit covers three basic concepts: Plant Structure, Plant Physiology, and Plant Ecology. The unit is based on the "discovery" approach and is used with children from 5-12 years of age.

Science Research Associates

Earth's Atmosphere Laboratory
Weather and Climate Laboratory
Solar System Laboratory

Learnings in Science Laboratories provide opportunities for children in elementary school to learn by observing and inquiring--just as scientists do. Planning, predicting, and experimenting, each child learns how to analyze and draw his own conclusions. Each laboratory contains for the student: Research Booklets, Record Books, Key Cards, and Key Model Booklets; and for the teacher: Teacher's Handbook, Instructional Aid Booklet, Laboratory Picture Chart, and Content Guide Chart.

Materials Needed:

The Earth's Atmosphere Lab, the Solar System Lab, and the Weather and Climate Lab can be obtained from Science Research Associates. Class Kits are included.

Talcott Mountain Science Center

The Talcott Mountain Science Center is a regional facility designed to assist towns in bettering their science programs. It provides assistance in all areas of science, but we have recommended its use chiefly in the earth sciences.

The outstanding staff at the Center is very enthusiastic and subscribes to the philosophy of science teaching we are espousing in this guide. The resources at the Center appear limitless, and the cooperative staff provides teachers with excellent ideas and interesting programs.

TMSC units which have been recommended in this guide may be used at many levels because of the varied sources of materials and flexible staff.

Teachers may arrange programs, such as field trips to the Center, visits to the school by staff members of the Center, or continuous programs, by contacting the Center. For information see Director Donald La Salle.

Resources and Field Trip Possibilities

Amateur Radio League
Newington, Connecticut

Bradley Airport-United States Weather Bureau
Granby, Connecticut

Brainard Field
Hartford, Connecticut

Bridgeport Museum of Science
Bridgeport, Connecticut

Camp Winding Trails
Farmington, Connecticut

Children's Museum
West Hartford, Connecticut

Children's Museum Planetarium
West Hartford, Connecticut

Clock Museum
Bristol, Connecticut

COPACO (Food Preparation)
Bloomfield, Connecticut

Corporate Systems
Farmington, Connecticut

Criterion Manufacturing(Telescope-Makers)
Hartford, Connecticut

Emhart Manufacturing (Glass Manufacturing)
Bloomfield, Connecticut

Farmington River
Farmington, Connecticut

Farmington River Watershed
Farmington, Connecticut

Forest Park
Springfield, Massachusetts

Hamilton Standard Aircraft
East Hartford, Connecticut

Hillstead Pond
Farmington, Connecticut

Peabody Museum
Yale, New Haven, Connecticut

Rocky Hill Dinosaur Park
Rocky Hill, Connecticut

Shade Swamp Sanctuary
Farmington, Connecticut

Sherwood Forest
Hartford, Connecticut

State Fish Hatchery
Burlington, Connecticut

Talcott Mountain Science Center
Avon, Connecticut

Talcott Mountain State Park
Avon, Connecticut

Travelers Data Processing Plant
Hartford, Connecticut

Travelers Research Center and
Meteorological Area
Constitution Plaza, Hartford, Conn.

Water and Sewage Treatment Plants
Farmington, Connecticut

WTIC-Channel 3 and WHNB-Channel 30
Hartford and New Britain, Connecticut

Horace R. Whittier, Naturalist
Bristol, Connecticut

SCIENCE PROGRESS FORM

Name ____________ Age ____________ Years in school ____________

Check Completed	Phase Units	Successfully met behavioral objectives for this phase (refer to guide)	Demonstrated competency in skills development	Demonstrated outstanding potential in the area of science
		Yes ☐ No ☐	Yes ☐ No ☐	Yes ☐ No ☐
			1. Observation 2. Classification 3. Measurement 4. Communication 5. Interpretation of facts 6. Drawing inferences 7. Setting up experiments 8. Making predictions 9. Application of processes to unfamiliar situations	
	Other Units	Comments	Comments	Comments

APPENDIX

Publisher	Address
Abelard-Schuman, Ltd.	6 West 57 Street, New York, N.Y. 10019
Abingdon Press	201 Eighth Avenue South, Nashville, Tenn. 37202
Addison-Wesley Publishing Company	Reading, Mass. 01867
Allyn and Bacon, Inc.	470 Atlantic Avenue, Boston, Mass. 02110
American Book Company	55 Fifth Avenue, New York, N.Y. 10003
American Education Publications	55 High Street, Middletown, Conn. 06457
American Library Association	50 East Huron Street, Chicago, Ill. 60611
American Technical Society	848 East 58 Street, Chicago, Ill. 60637
A. S. Barnes & Company	Forsgate Drive, Cranbury, N. J. 08512
Atheneum Publishers	162 East 38 Street, New York, N.Y. 10016
Barnes and Noble Inc.	105 Fifth Avenue, New York, N.Y. 10003
Benefic Press	10300 West Roosevelt Road, Westchester, Ill. 60153
Chas. A. Bennett Company, Inc.	809 West Detweiller Drive, Peoria, Ill. 61614
Benziger Brothers Publishing Company	7 East 51 Street, New York, N.Y. 10022
The Bobbs-Merrill Company, Inc.	4300 West 62 Street, Indianapolis, Ind. 46206
The Bruce Publishing Company	400 North Broadway, Milwaukee, Wis. 53201
Capitol Publishing Company, Inc.	850 Third Avenue, New York, N.Y. 10022
Chandler Publishing Company	124 Spear Street, San Francisco, Calif. 94105
University of Chicago Press	5750 Ellis Avenue, Chicago, Ill. 60637
Childrens Press, Inc.	1224 West Van Buren Street, Chicago, Ill. 60607

Publisher	Address
Chilton Book Company	401 Walnut Street, Philadelphia, Pa.19106
Coward-McCann, Inc.	200 Madison Avenue, New York, N.Y.10016
Thomas Y. Crowell Company	201 Park Avenue South, New York, N.Y. 10003
Crown Publishers, Inc.	419 Fourth Avenue, New York, N.Y.10016
The John Day Company, Inc.	62 West 45 Street, New York, N.Y.10036
T. S. Denison & Company, Inc.	315 Fifth Avenue South, Minneapolis, Minn. 55415
Dodd, Mead & Company	79 Madison Avenue, New York, N.Y.10016
Doubleday and Company, Inc.	Garden City, N. Y. 11530
Dover Publications	180 Varik Street, New York, N.Y. 11530
Earth Science Curriculum Project	Boulder, Colo. 80301
E. P. Dutton & Company, Inc.	201 Park Avenue South, New York, N. Y. 10003
Encyclopaedia Britannica, Inc.	425 North Michigan Avenue, Chicago, Ill. 60611
Feron Publishers, Inc.	2165 Park Boulevard, Palo Alto, Calif. 94306
The Fideler Company	31 Ottawa Avenue N.W., Grand Rapids, Mich. 49502
Follett Publishing Company	1010 West Washington Boulevard, Chicago, Ill. 60607
Franklin Watts, Inc.	575 Lexington Avenue, New York, N.Y. 10022
W. H. Freeman and Company	660 Market Street, San Francisco, Calif. 94104
Friendship Press	475 Riverside Drive, New York, N.Y.10027
Garrard Publishing Company	1607 North Market Street, Champaign, Ill. 61820

Publisher	Address
Ginn and Company	Statler Building, Back Bay P.O. 191 Boston, Mass. 02117
Globe Book Company, Inc.	175 Fifth Avenue, New York, N.Y. 10010
Golden Press, Inc. (Education Division)	850 Third Avenue, New York, N.Y. 10022
Goodheart-Willcox Company	18250 Harwood Avenue, Homewood, Ill. 60430
Grosset & Dunlap, Inc.	51 Madison Avenue, New York, N.Y. 10010
E. M. Hale and Company	1201 South Hastings Way, Eau Claire, Wis. 54701
Harcourt, Brace & World, Inc.	757 Third Avenue, New York, N.Y. 10017
Harper and Row, Publishers, Inc.	49 East 33 Street, New York, N.Y. 10016
Harvey House, Inc.	Irvington-on-Hudson, N.Y. 10533
Hastings House Publishers, Inc.	151 East 50 Street, New York, N.Y. 10022
Hawthorn Books, Inc.	70 Fifth Avenue, New York, N.Y. 10011
D. C. Heath & Company	285 Columbus Avenue, Boston, Mass. 02116
Hebrew Publishing Company, Inc.	79 Delaney Street, New York, N.Y. 10002
Henry Z. Walck, Inc.	19 Union Sq. W., New York, N.Y. 10003
Holiday House Inc.	18 East 56 Street, New York, N.Y. 10022
Holt, Rinehart & Winston, Inc.	383 Madison Avenue, New York, N.Y.10017
Houghton Mifflin Company	2 Park Street, Boston, Mass. 02107
International Text Book Company	Scranton, Pa. 18515
Alfred A. Knopf, Inc.	501 Madison Avenue, New York, N.Y. 10022
Laidlaw Brothers	Thatcher & Madison Streets, River Forest, Ill. 60305
Lantern Press, Inc.	257 Park Avenue South, New York, N.Y. 10010

Publisher	Address
J. B. Lippincott Company	East Washington Square, Philadelphia, Pa. 19105
Little, Brown and Company	34 Beacon Street, Boston, Mass. 02106
Lothrop, Lee & Shepard Company, Inc.	381 Park Avenue South, New York, N.Y. 10016
Lyons & Carnahan	407 East 25 Street, Chicago, Ill.60616
The Macmillan Company	866 Third Avenue, New York, N.Y. 10022
David McKay Company, Inc.	750 Third Avenue, New York, N.Y. 10017
Macrae Smith Company	225 South 15 Street, Philadelphia, Pa. 19102
Manufacturing Chemists Association	1825 Connecticut Avenue, N.W. Washington, D. C. 20009
McCormick-Mathers Publishing Company	P.O. Box 2212, 1440 East English Street, Wichita, Kans. 67201
McGraw-H ill Book Company	330 West 42 Street, New York, N.Y. 10036
McNight & McNight Publishing Company	Bloomington, Ill. 6170
Melmont Publishers, Inc.	1224 West Van Buren Street, Chicago, Ill. 60607
Charles E. Merrill Books, Inc.	1300 Alum Creek Drive, Columbus, Ohio 43216
Julian Messner (Division of Simon & Schuster, Inc.)	1 West 39 Street, New York, N.Y. 10018
University of Michigan Press	Ann Arbor, Mich, 48106
University of Minnesota Press	2037 University Avenue S. E. Minneapolis, Minn. 55455
William Morrow & Company, Inc.	425 Park Avenue South, New York, N.Y. 10016
National Science Teachers Association	1201 16 Street, Washington, D. C.
Thomas Nelson & Sons	6126 Copewood, Camden, N.J. 08103
The New American Library Inc.	1301 Avenue of the Americas, New York, N.Y. 10019

Publisher	Address
New York Graphic Society, Ltd.	104 Greenwich Avenue, Greenwich, Conn. 06830
Noble and Noble Publishers, Inc.	750 Third Avenue, New York, N.Y. 10017
W. W. Norton & Company, Inc.	55 Fifth Avenue, New York, N.Y. 10003
Pantheon Books	22 East 51 Street, New York, N.Y. 10022
Penguin Books, Inc.	7110 Ambassador Road, Baltimore, Md. 21207
J. Lowell Pratt & Company, Inc.	15 East 48 Street, New York, N.Y. 10017
Prentice-Hall, Inc.	Englewood Cliffs, N.J. 07632
G. P. Putnam's Sons	200 Madison Avenue, New York, N.Y.10016
Rand McNally & Company	P.O. Box 7600, Chicago, Ill. 60680
Random House, Inc.	457 Madison Avenue, New York, N.Y. 10022
Reader's Digest Services, Inc.	Educational Division, Pleasantville, N.Y. 10570
The Reilly & Lee Company	114 West Illinois Street, Chicago, Ill. 60610
Reinhold Publishing Company	430 Park Avenue, New York, N.Y. 10022
John F. Rider Company, Inc.	116 West 14 Street, New York, N.Y. 10011
St. Martin's Press, Inc.	175 Fifth Avenue, New York, N.Y. 10010
Scholastic Book Services	50 West 44 Street, New York, N.Y. 10036
Science Research Associates, Inc.	259 East Erie Street, Chicago, Ill. 60611
William R. Scott, Inc.	333 Avenue of the Americas, New York, N.Y. 10014
Scott, Foresman & Company	1900 East Lake Avenue, Glenview, Ill. 60025
Charles Scribner's Sons	597 Fifth Avenue, New York, N.Y. 10017

Publisher	Address
Silver Burdett Company	Morristown, N. J. 07960
Simon & Schuster, Inc.	630 Fifth Avenue, New York, N.Y. 10020
L. W. Singer Company (Division of Random House)	501 Madison Avenue, New York, N. Y. 10022
South-Western Publishing Company	512 North Avenue, New Rochelle, N.Y.10801
Sterling Publishing Company, Inc.	419 Park Avenue South, New York, N.Y. 10016
TAB Books, Inc.	See Scholastic Book Services
Teachers Publishing Corporation	23 Leroy Avenue, Darien, Conn. 06820
Frederick Ungar Publishing Company, Inc.	250 Park Avenue South, New York, N.Y. 10003
Vanguard Press, Inc.	424 Madison Avenue, New York, N.Y. 10017
D. Van Nostrand Company, Inc.	120 Alexander Street, Princeton, N.J. 08540
The Viking Press, Inc.	625 Madison Avenue, New York, N.Y. 10022
Time-Life Books (Division of Time, Inc.)	Time & Life Building, Rockefeller Center, New York, N.Y. 10020
University of Washington Press	Seattle, Wash. 98105
Harr Wagner Publishing Company	609 Mission Street, San Francisco, Calif. 94105
Wadsworth Publishing Company, Inc.	Belmont, Calif. 94002
Watson-Guptill Publications, Inc.	165 West 46 Street, New York, N.Y. 10036
Franklin Watts (Division of Grolier)	575 Lexington Avenue, New York, N.Y.10022
Webster Publishing (Division of McGraw-Hill Book Company)	Manchester Road, Manchester, Mo. 63011
Wesleyan University Press	100 Riverview Center, Middletown, Conn. 06457

Publisher	Address
Whitman Publishing Company	1220 Mound Avenue, Racine, Wis.53404
Wittlesey House (Division of McGraw-Hill Book Company)	330 West 42 Street, New York, N.Y. 10036
World Publishing Company	119 West 57 Street, New York, N.Y.

APPENDIX

Film and Filmstrip Distributors

Film Distributors

Academy Films, 1145 North Las Palmas Avenue, Hollywood, Calif.

Almanac Films, Inc., 29 East 10 Street, New York, N.Y.

Avis Films, Inc.,P.O. Box 643, Burbank, Calif.

Bailey Films, Inc., 6509 De Longpre Avenue, Hollywood, Calif. 90028

Charles Cahill and Associates, 5746 Sunset Boulevard, Los Angeles, Calif.90028

Cenco Films, Inc., 1700 Irving Park Road, Chicago, Ill.

Churchill Films, 662 North Robertson Boulevard, Los Angeles, Calif. 90059

Coronet Instructional Films, Coronet Building, Chicago, Ill, 60601

Dallas Jones Productions, Inc., 430 West Grand Place, Chicago, Ill.

Pat Dowling Pictures, 1056 South Robertson Boulevard, Los Angeles, Calif.

Educational Horizons, 3015 Dolores Street, Los Angeles, Calif.

Encyclopaedia Britannica Films, Inc., 425 North Michigan Avenue, Chicago, Ill.

Farmington Film Library, West District School

Film Associates of California, 11559 Santa Monica Boulevard, Los Angeles,
Calif. 90025

Films, Inc. (see Encyclopaedia Britannica Films, Inc.)

Gateway Productions, Inc., 1859 Powell Street, San Francisco, Calif.

Jam Handy Organization, 2821 East Grand Avenue, Detroit, Mich. 48211

Peter Hollander, 80 Ellery Street, Cambridge, Mass.

Indiana University, Audio-Visual Center, Bloomington, Ind.

International Film Bureau, Inc., 332 South Michigan Avenue, Chicago, Ill.60604

Journal Films, 909 Diversey Parkway, Chicago, Ill. 60614

McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, N.Y. 10036

National Educational Television (see Indiana University)

Official Films, Inc., 776 Grand Avenue, Ridgefield, N.J.

Rampart Productions, 401 Taft Building, Los Angeles, Calif.

Tabletopper Productions, 111 East 6 Street, P.O. Box 706, Carson City, Nev.

United World Films, Inc., 1445 Park Avenue, New York. N.Y. 10029

* University of Connecticut A. V. Center, Storrs, Conn.

Young America Films, Inc. (see McGraw-Hill Book Co.)

Filmstrip Distributors

Stanley Bowmar Company, Inc., 12 Cleveland Street, Valhalla, N. Y.

Canadian National Film Board, 1271 Avenue of the Americas, New York, N.Y.

Childrens Press, Inc., 1224 West Van Buren Street, Chicago, Ill. 60607

Creative Education, Inc., 340 North Milwaukee Avenue, Libertyville, Ill.

Curriculum Materials Corporation, 119 South Roach Street, Jackson, Mich.

Encyclopaedia Britannica Films, Inc., 425 North Michigan Avenue, Chicago, Ill. 60611

Eye Gate Productions, Inc., 146-01 Archer Avenue, Jamaica, N. Y. 91435

Filmstrip House, 432 Park Avenue South, New York, N.Y. 10016

International Visual Education Services, Inc., 300 South Racine Avenue, Chicago, Ill.

Jam Handy Organization, 2821 East Grand Avenue, Detroit, Mich. 48211

McGraw-Hill Book Company, Inc., 330 West 42 Street, New York, N.Y. 10036

Moody Institute of Science, 12000 East Washington Boulevard, Whittier, Calif. 90606

* Many films are available at a small rental charge.

NET Film Service, Indiana University, Audio-Visual Center, Bloomington, Ind.

Charles Scribner's Sons, Educational Dept., 597 Fifth Avenue, New York, N.Y. 10017

Society for Visual Education, Inc., 1345 West Diversey Parkway, Chicago, Ill. 60614

Stillfilm, Inc., 35 South Raymond Avenue, Pasadena, Calif.

Young America Films, Inc. (see McGraw-Hill Book Company)

Your Lesson Plan Filmstrips, 1319 Vine Street, Philadelphia, Pa.

Equipment and Supply Distributors

Aloe Scientific
1831 Olive Street
St. Louis 3, Mo.

Biological Supply Company
1176 Mount Hope Avenue
Rochester, N. Y.

Brockton Worm Hatchery
Mrs. Eleanor Sylvester
18 A Fuller Street
Brockton, Mass.

California Biological Service
1612 W. Glenoake Boulevard
Glendale, Calif.

Cambosco Scientific Company, Inc.
342 Western Avenue
Boston, Mass. 02135

Carolina Biological Supply Company
Elan College, N. C.

Central Scientific Company
1700 Irving Park Road
Chicago, Ill.

Conn. Valley Biological Supply Company
Valley Road
Southampton, Mass.

Creative Play Things, Inc.
Edinburg Road
Cranbury, N. J. 08512

Denoyer-Geppert Company
5235 Ravenswood Avenue
Chicago, Ill.

Edmund Scientific Company
Barrington, N. J.

Fisher Scientific Company
717 Forbes Avenue
Pittsburgh, Pa.

General Biological Supply House
761 East 69 Place
Chicago, Ill.

H. C. Hazel and Sons
Eustis, Fla. 32726

Hail Corporation
210 South Fourth Street
St. Louis, Mo.

Kuy-Sheerer Corporation
2109 Borden Avenue
Long Island City, N.Y.

Macalaster Scientific Corp.
Waltham Research and Development Park
186 Third Avenue
Waltham, Mass. 02154

Macalaster Bicknell, Inc.
181 Henry Street
New Haven, Conn. 06511

Marine Biological Laboratory
Woods Hole, Mass.

Michigan Scientific Company
P. O. Box 1005
Ann Arbor, Mich.

National Biological Supply Company, Inc.
2325 South Michigan Avenue
Chicago, Ill. 60616

New York Biological Supply Company
609 West 51 Street
New York, N.Y.

A. J. Nystrom and Company
3333 Elston Avenue
Chicago, Ill.

Oregon Biological Supply Company
1806 S. E. Holgate Boulevard
Portland, Ore.

E. H. Sargent and Company
4601 West Foster Avenue
Chicago, Ill.

Scientific Glass Apparatus Company
Bloomfield, N. J. 07003

Scientific Supplies Company
173 Jackson Avenue
Seattle, Wash.

Selective Educational Equipment
3 Bridge Street
Newton, Mass. 02195

Southern Biological Supply Company
517 Decatur
New Orleans, La.

Standard Scientific Supply Corp.
808 Broadway
New York, N. Y.

Stansi Scientific Company
1231-41 North Honore Street
Chicago, Ill. 60022

Arthur H. Thomas Company
Vine Street at Third, P.O.Box 779
Philadelphia 5, Pa.

University Apparatus Company
2229 McGee Avenue
Berkeley, Calif.

Ward's Natural Science Establishment, Inc.
P.O. Box 24, Beechwood Station
Rochester, N.Y.

The Welch Scientific Company
1515 Sedgwick Street
Chicago, Ill.

Western Laboratories
826 Q. Street
Lincoln, Neb.

APPENDIX

ESS Films and Film Loops

The following distributors are currently marketing ESS film loops:

Association Instructional Materials
600 Madison Avenue
New York, New York 10022

Kaydee Films, Ltd.
National Instructional Films
58 East Route 59
Nanuet, New York 10954

Macalaster Scientific Company
186 Third Avenue
Waltham, Mass. 02154

Modern Talking Picture Service, Inc.
1212 Avenue of the Americas
New York, New York 10036

Popular Science Publishing Company
A-V Division, Inc.
355 Lexington Avenue
New York, New York 10017

The Ealing Corporation
2225 Massachusetts Avenue
Cambridge, Mass. 02140

Universal Education and Visual Arts
221 Park Avenue South
New York, New York, 10003

Webster Division
McGraw-Hill Book Company
Manchester Road
Manchester, Missouri 63011

The following classroom films can still be rented from the EDC Film Library, 55 Chapel Street, Newton, Massachusetts 02160.

Gases and Airs in the Classroom
How to Make a Mealworm Back Up
A Small Things Classroom
Classrooms in Transition
Another Way to Learn